UNDERSTANDING THE INFLUENCE OF A CONTEXTUAL FACTOR,

STIGMA CONSCIOUSNESS:

A BARRIER FOR UNDERREPRESENTED STUDENTS IN ENGINEERING

A Dissertation

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by

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The undersigned, appointed by the dean of the Graduate School, have examined the dissertation entitled

UNDERSTANDING THE INFLUENCE OF A CONTEXTUAL FACTOR,

STIGMA CONSCIOUSNESS:

A BARRIER FOR UNDERREPRESENTED STUDENTS IN ENGINEERING

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Abstract

The present study used Social Cognitive Career Theory (SCCT; Lent, Brown, & Hackett, 1994) to examine the influence of racial/ethnic stigma consciousness on persistence intention among 263 underrepresented racial/ethnic minority engineering students. Path analysis was used to test a model depicting relationships between contextual (i.e., racial/ethnic stigma consciousness, institution types) and person-cognitive (i.e., self-efficacy, positive and negative outcome expectations, persistence intention) variables as hypothesized in SCCT. Results indicated that both hypothesized indirect and direct structural models provided an excellent fit to the data, but the hypothesized indirect model showed better fit. Test of mediation was statistically significant for engineering self-efficacy, but not for positive and negative outcome expectations in the relations between racial/ethnic stigma consciousness and persistence intentions. Results of moderated mediation indicated a significant interaction of coping efficacy on racial/ethnic stigma consciousness on the indirect effect via engineering self-efficacy. A series of ANOVA and MANOVA were also conducted to determine whether demographic and contextual variables could explain racial/ethnic stigma consciousness, coping efficacy, and socio-cognitive variables (i.e., self-efficacy, positive and negative outcome expectations, persistence intentions) to pursue engineering degree. Suggestions for future research directions, clinical implications, and limitations are further provided.

CHAPTER I

INTRODUCTION

Background

Over the past quarter century, scientific and technical capabilities have been established as engines of economic growth in the global market, both increasing global collaboration and competition (National Science Board, 2018). Indeed, Science, Technology, Engineering, and Mathematics (STEM) knowledge has been increasingly a key input to production in the marketplace, accounting for nearly one-third (31%) of global output as well as leading the major economies at 38% of its GDP. Along with this higher demand, careers in STEM fields rank among the fastest-growing in the U.S. (Fayer, Lacey, & Watson, 2017). Compared with 5.2 percent net growth in non-STEM occupations, employment in STEM occupations grew by 10.5 percent, or 817,260 jobs, between 2009 and 2015. The Bureau of Labor Statistics (BLS) also indicated the fast-paced projected growth rates for STEM occupations between 2016 and 2026, including new job openings (e.g., mathematical science occupations group at 28.2% vs. all occupations at 6.5%). This growth cannot be overlooked, considering that ninety-three out of 100 STEM occupations had wages above the national average.

Reflecting on the crucial impact of Science, Technology, Engineering, and Mathematics (STEM) on our economy and global competition, a focus has been on STEM development in our nation's greatest asset—people. STEM education has been considered a crucial component of a well-rounded education for all students that results in the skills and mindsets that open the door for lifelong education. From a report by Tanenbaum (2016), the process of learning and practicing the STEM disciplines was emphasized to instill in students a passion for inquiry and discovery and foster skills such as persistence, teamwork, and the application of gained knowledge to new situations (Bailey, Kaufman, & Subotic, 2015; Betrus, 2015). Experts contend

that these are the types of growth mindsets and habits that demonstrate one's capacity for academic tenacity and lifelong learning in a rapidly changing world (Dwekc, Walton, & Cohen, 2014; Sharples, 2000). As a result, a variety of initiatives and programs are being increasingly implemented to promote STEM interest and participation among students, such as President Obama's "Educate to Innovate" campaign (White House.gov, 2009) and the Trump administration's five-year lesson plan for boosting STEM (National Science & Technology Council, 2018).

Despite of these large-scale efforts, prior research has shown that students leave the STEM pipeline at various transition points along their education. Furthermore, the percentage of students who declare a STEM-related major in college continues to lag behind what would be expected based on students' intentions. Specifically, of the roughly 1.9 million students in the 2015 ACT-tested high school graduate cohort, 40% expressed interest in majoring in a STEM field. An additional 9% of students who did not express an interest in a STEM major had measured interests in STEM based on their responses to the ACT Interest Inventory (ACT, 2015). National statistics suggest that fewer than 30% of students actually declare a STEM major in college (Chen, 2013; Chen & Ho, 2012). With this trend, the pool of prospective STEM workers will continue to dwindle as well (Chen, 2013), which is likely to influence the U.S.'s competitiveness in the global economy (Langdon, McKittrick, Beede, Khan, & Doms, 2011). Therefore, it is clear that identifying the characteristics of students and environments to support students' interests in and persistence in STEM degrees is important, and that this information can be used to inform targeted interventions to increase STEM participation and to promote STEM participation.

The United States' demographic diversity is a distinct competitive advantage (National Science Board, 2018). Indeed, research has shown the positive impact of diversity on workplace productivity and innovation (Hewlett, Marshall, & Sherbin, 2013; Ellison, & Mullin, 2014). For example, Hewlett and colleagues (2013) reported the positive impact of diversity that unlocks innovation and drives market growth from a nationally representative survey of 1,800 professionals, 40 case studies, and numerous focus groups and interviews. From their study, inherently (i.e., having traits individuals are born with) diverse contributors (e.g., gender, ethnicity, sexual orientation) understand the unmet needs in underleveraged markets. Specifically, they documented the entire team better understand the users when at least one member of a team has traits in common with the end users, resulting 152% likelier understanding than another team who does not share a client's ethnicity. Given that innovation is a significant component in developing STEM fields, it is critical to understand how to leverage the talents of all segments of the population, particularly groups historically that have been underrepresented in STEM fields.

Statement of the Problem

In spite of critical role of diversity in STEM, significant disparities among different ethnicities in STEM education still remain. Although the share of STEM degrees awarded to underrepresented minorities (URM; i.e., Hispanics or Latinx, Blacks or African Americans, American Indians or Alaska Natives, Native Hawaiian or Other Pacific Islander, and individuals from more than one race) has increased over the past two decades (National Science Foundation, 2019), only 15% of STEM degree holders and 11% of STEM workers are identified as URM. This is a significantly low proportion, considering that URM make up 27% of the U.S. population age 21 and older. Specifically, about 58.7% of bachelors' degrees in STEM fields

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were awarded to Whites in 2016, and an additional 11.4% were awarded to Asians. On the other hand, only 5.8%, 10.6%, 0.4%, 0.2%, and 3.7% of STEM bachelors' degrees were awarded to Hispanic or Latinx, Black or African Americans, American Indians or Alaska Natives, Native Hawaiian or Other Pacific Islander, and biracial/multiracial individuals, respectively in 2016. This gap seems to increase among advanced degrees that are awarded, as URM doctoral awardees only made up 13.5%, compared to 68.3% and 10.9% of White and Asian doctoral awardees in STEM fields (NSF, 2019).

Among STEM fields, it should come as no surprise that the field of engineering has a diversity problem. Historically an area dominated by White, middle and upper-class men, that legacy remains primarily unabated. Indeed, URM students are substantially underrepresented in the field and have the highest attrition rate compared to White or Asian American groups in undergraduate engineering programs. In 2016, Latinx, African American, American Indians, Native Hawaiian, and biracial/multiracial individuals earned 10%, 4%, 0.3%, 0.1%, and 3% of undergraduate engineering degrees, respectively (NSF, 2019). In contrast, Whites earned 63.4% of engineering degrees in 2016. Furthermore, URM make up a small fraction of the engineering field—amounting to some 14 percent of total engineering occupation workers, while White and Asian individuals represent 69% and 16% of the total engineering workforce, respectively. Given that the non-Hispanic White-alone population is projected to shrink over the coming decades, making them a "minority White" in 2045 (Frey, 2018), this continued gap should be seriously considered.

Different reports have documented the important role of Minority Serving Institutions (MSIs) in promoting URM students' participation in STEM (e.g., NSF, 2019). According to the report by National Center for Science and Engineering Statistics (NCSES, 2017a), a substantial

number of URM students enrolled in MSIs for their postsecondary degrees. Indeed, MSIs'

effectiveness in facilitating the STEM educational attainment of URM students has been

documented by many scholars (e.g., Contreras, Bensimon, & Malcom, 2008; Harmon, 2012).

Jackson and Rudin (2019) insisted that students who graduate from MSIs do as well as, or even

better than, those who attended non-MSIs in achieving upward income mobility. For example,

data indicate that graduates from MSIs move from the lowest to the highest income quintile by

age 30 (Jackson & Rudin, 2019). MSIs are crucial resources not only for increasing the number

of URM students who major in STEM fields by building new or reinforcing existing disciplines,

but also for fostering the success of URM students in STEM fields to degree completion and

even further. On the other hand, scholars have consistently documented the atmosphere of

Predominantly White Institutions (PWIs) as a deterrent to URM students for their academic

growth and social involvement in general, particularly in STEM. According to studies, many

URM students described the campus climate of PWIs as chilly, alienating, unsupportive, and

perpetuators of racial microaggressions (Smith, Yosso, & Solórzano, 2007; Solórzano, Ceja, &

Yosso, 2000; Solórzano & Yosso, 2002), resulting in experiencing stress on a variety of levels,

such as racial discrimination and interracial stresses (Smedley, Myers, & Harrell, 1993). Indeed,

the minimal representation of URM students on campus is likely to create additional challenges

for URM students in STEM. In a study of Black students attending a large PWIs, for example,

Black female students recounted experiences with frequent microaggressive behaviors from

faculty who encouraged them to pursue non-STEM majors, inducing negative racial stereotypes

threat (johnson, 2007). Although accumulated studies showed the important role of MSIs for

URM students in STEM fields, there is only few research studies that has been conducted

focusing on engineering majors in which institutional context has been examined (e.g., Garriott

et al., 2019). Given distinctive features of each fields even within STEM areas, further investigation of the potential environmental factors that influence on URM students' retention in engineering should be considered.

Stereotype threat has been used to understand racial/ethnic performance discrepancies in a broad range of evaluative domains and produces numerous negative consequences, ranging from reducing working memory capacity (Schmader, Johns, & Forbes, 2008) to identity conflict (Pronin, Steele, & Ross, 2004) and disengaging from the domain in question (Alter, Aronson, Darley, Rodriguez, & Ruble, 2010; Steele, Spencer, & Aronson, 2002b; Stout, Dasgupta, Hunsinger & McManus, 2011). Continuous disengagement resulting from repeated experiences of racial antagonism may influence persons to "disidentify" by distancing themselves from their performance in a particular domain, possibly causing people to permanently opt out of that domain, such as STEM fields for stereotyped groups (Nussbaum & Steele, 2007). Research has shown that negative academic performance resulted by feeling performance burden and decreasing work effort among stigmatized groups in STEM (Fischer & Massey, 2007), which ultimately effects the attrition of minorities from STEM majors (Beasley & Fischer, 2012). This stereotype threat is particularly activated by socially-ascribed stereotypes. Research suggested that the environment can be a potent source of creating threat (Logel, Iserman, Davies, Quinn, & Spencer, 2009) that activates stereotyped beliefs and leads to negative influences on performance and experiences, even in cases where specific stereotypes were not made explicitly (Smith & White, 2002). Instead, simply being in a setting that is White dominated and/or known to relate to racial/ethnic stereotypes are enough to undermine historically underrepresented students' performance and motivation in STEM fields.

Similarly, scholars have expressed concerns regarding *tokenism* among URM students may experience and its impact on their experience in college when each URM group comprises less than 15% of students enrolled in college (Kanter, 1977). In research on the function of ethnic distinctiveness in the social environment (McGuire, McGuire, Child, & Fujioka, 1978), participants indicated keen awareness of their uniqueness when they were the sole specific ethnic individual (e.g., Latina) in a group of mostly Whites. these feelings of distinctiveness have side effects that could negatively affect an URM individual's performance—such as difficulties concentrating (Lord & Saenz, 1985) and lowered feelings of self-competence (Mellor, 1995). That is, URM students in STEM who occupy a token status in PWIs may experience a situationally induced increase in vigilance upon arriving at college. Despite its significant and varied influence on URM students in different settings, to date, much of the research in this area involves the analysis of experimental rather than observed data obtained in natural academic settings. The current study aims to complement experimental work in this area by examining URM students' perceptions of these social psychological factors.

As a way to explain URM students' internal process of social stereotype, Pinel (1999) suggested a newly articulated concept, *stigma consciousness*, to capture stereotypes' effects in real-world situations. Stigma consciousness is considered a schema of anticipation that others will stereotype a person regardless of that person's behavior. Historically underrepresented students who are high in stigma consciousness tend to perceive greater discrimination against themselves and members of their group (Pinel, 1999) and are more vigilant to race-related threats (Major & O'Brien, 2005). As a result, highly stigma conscious individuals from URM groups tend to report increased psychological distress, greater susceptibility to stereotype threat, and lower self-esteem (Brown & Lee, 2005; Pinel, Warner, & Chua, 2005), especially in the context

of ambiguous discrimination (Wang, Stroebe, Dovidio, 2012). With respect to racial/ethnic minorities, stigma consciousness is associated with greater evaluative concerns, an increased threat vigilance, and a higher level of psychological distress (Burgess, Molina, Bhandari, & Dibartolo, 2018; Major, Mendes, & Dovidio, 2013).

To understand the interplay between a variety of person, environmental, and behavioral variables in engagement and persistence in STEM majors and occupations, a growing literature has emerged employing social cognitive career theory (SCCT; Lent, Brown, & Hackett, 1994; 2000) as a conceptual framework. SCCT has been applied in understanding persistence among female, male, and racially diverse college student samples in a variety of STEM fields (e.g., Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; Lent et al., 2005; Lent, Lopez, Sheu, & Lopez, 2011). (For recent reviews of this literature, see Brown & Lent, 2016; Flores et al., 2014; Lee, Flores, Navarro, & Kanagui-Munoz, 2015). Particularly, to understand the career development of individuals who are historically underrepresented in STEM fields, the role of proximal contextual influences has been considered as a critical component (Byars-Winston & Fouad, 2008; Lent et al., 2000). Such influences in the form of barriers have been shown to relate directly to self-efficacy and indirectly (via self-efficacy) to choice goals and actions (Lent et al., 2003, 2007, 2014, 2018). Self-efficacy, in turn, has been a strong predictor of both persistence intentions (Brown et al., 2008; Robbins et al., 2004; Wright, Jenkins-Guarnieri, & Murdock, 2012) and actual persistence (Lee et al., 2015). Importantly, path coefficients among SCCT core variables, including proximal contextual variables (i.e., supports, barriers), were reported varied depending on groups (i.e., majority vs. minority). For example, Lent et al. (2018) documented a stronger path from outcome expectations to goals in URM students, while the path from outcome expectations to interests was smaller in URM students than in racial/ethnic majority (e.g.,

White), suggesting a potential impact of hospitable environment on nurturing outcome expectation. Very little research has focused on barriers within the achievement environment where important academic/career-related attitudes can be formed or reactivated (see Fouad et al., 2010, for an exception).

SCCT has been also served as the major theoretical framework exploring factors that contribute to understand the relatively low retention rate of the URM students in STEM fields. As the model explicitly incorporates person inputs (e.g., gender) and proximal and distal contextual influences (e.g., support and barrier), scholars have used SCCT as a frame to examine gender differences (Kanny, Sax, & Riggers-Piehl, 2014) in STEM careers and review research explaining STEM choices and work decisions for women and racial/ethnic minorities (Fouad & Santana, 2017). Research has generally supported the model across college students with different genders, racial/ethnic minorities, and the year in school (Lent et al., 2005, 2011; Flores et al., 2014), particularly the segments of interest and choice segment. However, there was only mediated path between interest and persistence through satisfaction rather than a direct path from interests to persistence (Lent et al., 2013; Navarro et al., 2013) among engineering students in different types of institutional types (i.e., HBCUs, HSIs). From these findings, authors noted the potential significance of the environment in retaining URM students (Lent et al., 2013). Furthermore, Herrera and Hurtado (2011) reported that URM reported higher level of maintained interests in a STEM career with a clearer vision for a specific career from freshmen to senior year when they experienced working with faculty on research. Having role models, receiving social supports and educational opportunities, and feeling a sense of belonging were also listed as factors that enhanced URM's level of self-efficacy in their disciplines. This is important because self-efficacy significantly relates to URM students' performance accomplishments

(Ceci, Ginther, Jahn, & Williams, 2015; Byars-Winston & Fouad, 2008; Blake-Beard, Bayne, Crosby, & Muller, 2011; Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2009). This highlights the dynamic interplay between environmental factors and social-cognitive factors on URM students' persistence. Therefore, the present study will examine the possible influence of the context- and race/ethnicity-dependent variable of stereotype threat on URM students' self-efficacy for pursuing an engineering degree, as facilitating the type of proximal aversive effects theorized by Lent et al. (2000).

Purpose of the Current Study

The purpose of the proposed study is to examine the influence of proximal contextual barriers and stigma consciousness as a predictor of engineering persistence intentions among URM students using the SCCT framework. Coping with barriers will be included as an individual difference that may explain how URM students interpret their environment generally and, in turn, form efficacy beliefs regarding their performance. Given that a substantial fraction of URM earned their science and engineering bachelor's degree from minority-serving institutions (MSIs; NSF, 2019), two distinct college environments (i.e., PWIs vs. MSIs) will be targeted to recruit eligible participants to better understanding the dynamic between environmental and individual levels. Specifically, levels of stigma consciousness, academic self-efficacy, coping efficacy and persistence intentions will be compared across institutional type and across participants' majority and minority status . URM students can experience both majority and minority status depending on where they are. For example, they might be a majority group in HSIs, even though their overall representation in engineering is minority. In addition, the moderation effects of coping efficacy and institution types depending on their majority and

minority status will be investigated in the relationship between stigma consciousness and self-efficacy.

Hypotheses

H1. The hypothesized structural model will provide a good fit to the data and variables will related hypothesized by SCCT.

- ✓ H1-1) Engineering self-efficacy will be negatively related to stigma consciousness.
- ✓ H1-2) Coping efficacy will be positively related to engineering self-efficacy and negatively related to stigma consciousness.

H2. Person-cognitive variables (i.e., self-efficacy, outcome expectation) will mediate the relations between stigma consciousness and persistence intention.

H3. Coping efficacy will moderate the relationship between stigma consciousness and engineering self-efficacy.

- ✓ H3-1) Coping efficacy will be weakening the relationship between stigma consciousness and engineering self-efficacy.
- ✓ H3-2) Coping efficacy will be weakening the relationship between stigma consciousness and positive engineering outcome expectations
- ✓ H3-3) Coping efficacy will be aggravating the relationship between stigma consciousness and negative engineering outcome expectations.

H4. Students who attending PWIs will report the higher level of stigma consciousness than students who attending MSIs.

CHAPTER II

LITERATURE REVIEW

This chapter will provide an integrative review of variables used to test an extended and partial model of Social Cognitive Career Theory (SCCT; Lent et al., 1994; 2000) within the domain of STEM, specifically engineering. This chapter will begin with a brief description of the Underrepresented Racial/Ethnic Minority (URMs) students within STEM, specifically in engineering and an overview of past and current research that have examined their career development in engineering fields. This brief review will highlight trends in previous research and the need for further investigations of socio-contextual factors and their role in the career development of URMs. A summary of SCCT will be provided with an emphasis on Lent et al.'s social cognitive model of career choice behaviors (1994; 2000), as the current study aims to understand the reciprocal interplay of intrapersonal, behavioral, and environmental determinants in URM students' career development in engineering disciplines. A discussion of the literature related to direct and indirect influences of personal, contextual, and intersectional factors that will be tested in the present study will be highlighted for each major SCCT construct that is tested.

Underrepresented Racial/Ethnic Minority (URM) in STEM and engineering.

Employment in science, technology, engineering and mathematics (STEM) occupations has grown—outpacing overall job growth, as the U.S. has transformed rapidly to an information-based economic society. Since 1990, STEM employment has grown 79% (9.7 million to 17.3 million), whereas the overall employment rate grew only 34% (Fayer et al., 2017; Graf, Fry, & Funk, 2018), referring a vital role of the STEM fields in the economic prosperity and national security of the United States. According to researchers (e.g., Fayer et al., 2017), this increasing

trend will continue into the future. For example, the projected job openings for types of STEM occupations (i.e., the combination of new jobs and jobs expected to result from workers permanently leaving occupations and needing to be replaced) yields over 1 million job openings from 2014 to 2024, even when considering on the STEM occupations in computer fields. Engineering jobs are also reported to grow by 8% between 2014 and 2024, given the emphasis on automation and software. Given that economies are more likely to rely on a skilled workforce and sustained investment to produce knowledge streams, new technologies, and discoveries, this high demand for a STEM workforce might not be a surprising fact.

However, there has been a growing problem in the U.S. with the shortage of qualified STEM workers and, the proportion of STEM degrees has declined over the last several decades. Specifically, the U.S. Congress Joint Economic Committee (2012) reported a decrease in the proportion of STEM bachelor's degree from 24% in 1985 to 18% in 2009. There has been a push to increase its yearly production of undergraduate STEM degree by 34% over the current rate to match the demand forecast for STEM professionals (President's Council of Advisors on Science and Technology, 2012). These arguments add weight, given the current global competition and the U.S.'s continued lag behind many other countries in basic STEM skills (National Science Board, 2018). Consequently, there have been active discussions to promote STEM interest and participation in different levels from developing learning strategies (e.g., "Teaching data science through community" by partnering local government and business) to addressing federal strategies (e.g., "Charting a course for success: America's strategy for STEM education" by the committee on STEM education of the national science & technology council).

The lack of diversity in the STEM workforce and the lack of graduates in these fields have long concerned researchers and policy-makers along with a lack of graduates in these

fields. Indeed, the committee on STEM education of the National Science and Technology Council (2018) listed "increase diversity, equity, and inclusion in STEM" as one of three goals for achieving global competitiveness, noting a partial success with limited individuals' engagement in STEM foundation. This lack of diversity is largely attributed to the failure of the academic "pipeline" to maintain a steady flow of underrepresented minority (URM) students in STEM. In secondary education, the evident and consistent achievement gaps between White students and URM students have been reported regarding STEM subjects in early years. For example, in 2015, 12th grade White students scored 30 points higher than Black students and 22 points higher than both American Indian/Alaska Native and Latinx students in their National Assessment of Educational Progress Mathematics assessment (McFarland, et al, 2019). These scores for White 12th-grade students were higher than the scores for their Black and Latinx peers in every survey year since 2005, not showing any measurably difference from the corresponding gaps in 2005. Given the recent survey that about half of adults (52%) indicated their main reason for not pursuing STEM degree is due to the difficulty of the subjects (Kennedy, Hefferon, & Funk, 2018), the influence that is likely to reduce the interest in STEM for URM students can be inferred.

The disparity among different racial/ethnic students is consistent in STEM postsecondary education. The gap in educational attainment at the bachelor's level between URM and Whites has narrowed but continue to be wide (National Science Board, 2018). Although the racial and ethnic composition of the cohort of bachelor's degree recipients in STEM has changed over time, population changes and increasing rates of college attendance by URM, the share of STEM degrees awarded to, Latinx students increased from 7% to 13% between 2000 and 2015. However, STEM degrees awarded to Black students has remained flat (i.e., 9%) since 2000; and

the share awarded to American Indians or Alaska Natives dropped from 0.7% to 0.5% in this period. STEM degrees awarded to Whites declined from 71% to 61%, and the share awarded to Asians increased from 9% to 10%. Similarly, the proportion of STEM master's degrees earned by URM students increased from 14% to 21% between 2000 and 2015, but the proportion earned by Whites was 60%. Among STEM doctoral degree recipients, White students still share 44% of all U.S. STEM doctorates, showing a rise in the number of STEM doctorates, although the number and the proportion of doctoral degrees earned by URM students increased (National Science Board, 2018).

A steady and disproportionate trend is documented in the STEM workforce as well. In 2015, among 6.4 million workers employed in STEM-relevant occupations, 67% and 21% were Whites and Asian, respectively. On the contrary, Latinx only shared 6% of STEM workforce, following by Black (4.8%), More than one race (1.6%), American Indian or Alaska Native (0.2%), and Native Hawaiian or Other pacific Islander (0.2%), comprising the STEM workforce of underrepresented racial/ethnic group together as 12.8%. Considering the share of the U.S. population age 21 and older for URM is over 28%, this is a significantly low proportion.

The diversity issues exist not only in STEM as overall, but also engineering as a specific field. White and Asian students made up major proportion of engineering graduates, with 77.6% of total bachelor's degrees, 74.6% of master's degrees, and 76.9% of doctoral degrees (Yoder, 2017), denoting problematic racial/ethnic representation. The racial/ethnic composition in engineering labor force reveals equally disquieting numbers. Only 14% of engineers in the labor force are URM (i.e., Latinx 8.7%, Black 3.8%, More than one race 1.4%, Native Hawaiian or Other Pacific Islander 0.5%, American Indian or Alaska Native 0.3%), despite ongoing efforts across academia, government, and industry to increase their participation in engineering. Indeed,

William A. Wulf, president of the National Academy of Engineering, argued the detrimental effects of lacking diversity in the fields, as it is likely to lead a countless number of missed opportunities—ideas and potential innovations that are never able to come to fruition on account of barriers determined by socially constructed identity categories.

Accumulated research also has reported the benefits of diversity and inclusion in the workplace. According to scholars, companies with higher levels of gender and racial/ethnic diversity are linked to lower levels of employee turnover (Ali, Metz, & Kulik, 2015). Diverse companies are able to maximize talent and productivity (Sabharwal, 2014) by increasing job satisfaction and knowledge sharing. Furthermore, strong diversity climates were associated with the reduced instances of interpersonal aggression and discrimination (Drach-Zahavy & Trogan, 2013) as well as the experiences of trust and increased engagement at work (Downey, Werff, Thomas, & Plaut, 2015). Additionally, workplace diversity is believed to play as a critical role in innovation, which is significant in STEM workforce. When a workforce reflects the racial/ethnic diversity of its consumer base, employee productivity increase (Avery, McKay, Tonidandel, Volpone, & Morris, 2012). Specifically, they found companies earn 38% more of their revenues, on average, from innovative products and services when companies hold higher diversity in management team (Lorenzo, et al., 2017). That is, homogenous groups may be susceptible to groupthink, but diverse team can leverage a greater variety of perspectives and are likely to consider information more thoroughly and accurately. Considering that the United States' demographic diversity can be a distinct competitive advantage (National Science Board, 2018), leveraging the talents of all segments of the population should be pursued, particularly groups historically underrepresented in STEM.

Thus, the present study will focus on URM students in order to understand the factors that may encourage/hinder their participation in engineering fields and, ultimately, to use these findings to develop and implement effective educational and career interventions that will assist URMs academic persistence, career exploration, and career success in engineering. In recent years, promising theoretical models have been proposed to explain career choice in STEM and/or engineering domains. Of those, perhaps the most widely researched and disseminated theory is social cognitive career theory (SCCT; Lent et al., 1994, 2000).

Social Cognitive Career Theory

Social Cognitive Career Theory (SCCT; Lent et al., 1994; 2000) has been a major theoretical framework investigating factors that contribute to the underrepresentation of women and racial/ethnic minorities in STEM fields. Drawing from Bandura's (1986) social cognitive theory, SCCT postulates triadic reciprocal linkages among individual, contextual, and behavioral dimensions. Its comprehensive nature, incorporating personal, cognitive, and socio-contextual factors to understand career development, has allowed researchers to understand individuals' career development better in both individual level of analysis and the contextual level of analysis. Specifically, self-efficacy, outcome expectations, interests, and goals are thought to influence eventual career choices and persistence in consideration of individual predispositions, background affordances, learning experiences, and influences proximal to career choice behaviors. See Figure 1 for a visual representation of their model.

Person-cognitive variables. Self-efficacy, outcome expectations, career interests, career goals, and career choice are included as person-cognitive variables posited in SCCT. Self-efficacy is defined as, "people's judgments of their capabilities to organize and execute courses

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of action required to attain designated types of performances" (Bandura, 1986, p. 391). Within the social cognitive framework, self-efficacy highlights the agent role of individuals in the interplay among environmental factors, personality affective traits, and goals directed behaviors, and work satisfaction (Lent & Brown, 2008). Prior studies have documented that self-efficacy is reliably related to choice goals that people develop (Lent et al., 1994; 2018; Sheu et al., 2010) and moderately and slightly correlated with supports and barriers, respectively (Brown et al., 2018).

Self-efficacy is in turn thought to predict outcome expectations or "beliefs about the consequences or outcomes of performing particular behaviors" (Lent et al., 1994, p. 381). According to Bandura (1986), outcome expectations can be classified into physical, social, and self-evaluative categories. Examples of outcome expectations for pursuing a math or science-related career include the perception that a math/science career will lead to financial stability (e.g., physical), one's parents will be pleased with such a career choice (e.g., social), or having a math/science career could lead to a sense of personal fulfillment (e.g., self-evaluative). It has been suggested that self-efficacy beliefs and outcome expectations may differentially predict career interests based on environmental context or task and that self-efficacy may be a stronger predictor (Lent et al., 1994).

Lent and Brown (2008) also indicated the positive outcome expectations may indirectly influence on the satisfaction level by enhancing goal-directed behaviors. Furthermore, two meta analyses (Lent et al., 2018; Sheu et al., 2010) found that outcome expectations yielded larger direct paths to choice goals than did self-efficacy with interests. Its role as a mediator with self-efficacy between contextual supports and barriers and choice goals and actions (Lent et al., 2001;

Sheu et al., 2010) was also pointed out. Some inconsistent results on the role of outcome expectations in the development or expression of interests and goals have been reported.

Career interests are considered as the overall level of interests one experiences with regard to a specific career domain or academic subject, promoting the level of goal setting for the career. Thus, it is presumed that a student who expresses a great deal of interest in occupations clustered within engineering domains would actively pursuing a relevant career by setting some personal goals. Goals have been defined as the determination to pursue a particular outcome or to achieve a particular level of performance (Bandura, 1986; Locke & Latham, 1990a). The construct of goals has been underlined as a precursor for later career choice behavior, such as choosing a major and engaging career fair to pursue relevant opportunities that are ultimately presumed to enhance the domain specific satisfaction as well as life satisfaction (Diener, Suh, Lucas, & Smith, 1999; Lent et al., 1994; Ryan & Deci, 2001; Sheldon & Kasser, 1998). Within SCCT, career goals are theorized to motivate career-related behaviors such as planning and making decision to persist a specific career.

Contextual variables. The SCCT model's explicit incorporations of contextual influences at proximal and distal levels have gained significant level of attention from scholars who are especially interested in environmental influences on one's career development. Within the framework of SCCT, one's personal and environmental context can promote or impede success within a given domain through several different factors, such as personal inputs (e.g., gender), background contextual affordance (e.g., the access to the quality of education), and proximal contextual influences (e.g., perceived barriers and supports in pursuing a specific career) on career choice behaviors. These individual and environmental factors may provide vicarious influence as well as have direct, indirect, and moderating effects on one's socio-

cognitive processes (Lent et al., 1994, 2000). Importantly, Lent et al. (1994) emphasized that access to the learning experiences that influence in the development of self-efficacy and outcome expectations by the bi-directional interactions of between person inputs and background contextual affordances that play out during childhood and adolescence. In other words, the exposure to different learning environment that is likely to be dependent on one's gender, race/ethnicity, or ability status (i.e., person inputs) as well as social class and experiences of cultural socialization and oppression (i.e., background contextual affordances). For instance, a Latina who comes from low social economic status may not have the same access to extracurricular activities, role models, and strategies for coping as does White man in pursuing engineering. Such personal and contextual factors have been termed *distal* influences on career development given their relative distance from actual career choices.

Proximal contextual factors are postulated to interplay with cognitive and behavioral variables through both objectively and subjectively. That is, individuals can be seen as an active agent who appraises and construes differently the environment and themselves in SCCT (Vondracek, Lerner, & Schulenberg, 1986). As each individual may respond differently in terms of their phenomenological appraisal, proximal environmental variables can moderate and directly affect the processes by which people make and implement career-relevant choices. For example, the ignorant comments about math/science ability toward a Black man may reduce his level of interests in STEM that can connect to his decision to drop his major. However, it may make him be more motivated to cut this stereotype threat for other Black students in STEM. Lent et al. (1994, 2000, 2003) explicated the proximal influences will lead to associated interests, goals, and actions by assisting in determining whether self-efficacy and outcome expectations for a certain career in their distinction from background contextual factors.

In summary, three distinctive but interconnected SCCT models include: (a) interest and choice models (Lent et al., 1994, 2000) that were designed to explain how basic academic and career interests development, how basic academic and career choices are made, and what factors affect academic and career success (e.g., achievement and persistence), (b) a model of satisfaction and well-being in educational and vocational context (Lent & Brown, 2006a, 2008) that highlights the ultimate influence on work and life satisfaction, and (e) a model of career self-management (Lent & Brown, 2013) that relatively emphasizes on the micro-level processes, such as how individuals negotiate both normative development tasks (e.g., making career decisions) and less predictable events and crises (e.g., job loss) in the process of career development. In this current study, Lent's choice model (1994, 2000) will be used as the framework, focusing on contextual factors, to understand URM students' persistence intention in engineering (i.e., persistence in education) with the interplay among different person-cognitive and environmental variables.

SCCT Choice Model and Its Empirical Support.

SCCT choice model holds that self-efficacy beliefs are predictive of outcome expectations and that the two variables each account for unique variation in choice goals (e.g., one's desire to pursue a specific occupational path) as well as choice actions (e.g., one's effort to transform goals into concrete behaviors). In addition, choice goals and actions can be promoted or hindered by contextual supports and barriers via direct paths by moderating the relations of interests to goals and goals to actions (Lent et al., 1994), and via indirect paths through self-efficacy and outcome expectations (e.g., Lent et al., 2001; Sheu et al., 2010). Within the model, predictors and dependent variables must be within the same conceptual domain and at the same approximate level of content specificity as the primary theoretical focus. This is because the

better predictions will be obtained when matching happened between predictors and dependent variables regarding content, context, level of specificity, and temporality (Bandura, 1986; Lent & Brown, 2006b). Consequently, social cognitive constructs should be assessed with task-specific and domain-specific measures, of well-defined, practically relevant, and potentially modifiable dependent variables (Lent & Brown, 2006b).

Lent et al. (2000) introduced coping efficacy as having a potential complementary role relative to task self-efficacy in enabling performance and persistence at complex skills under adverse circumstances. According to Lent and colleagues (2000), coping efficacy reflects one's perceived capability to negotiate particular situational feature that obstruct or complicate performance. For instance, a female student may select a STEM-related major because of her high level of coping efficacy even though there are gender bias or negative peer pressure to pursue the major. That is, one of the ways that the perception of barriers can have a particularly salient influence on career development is through coping efficacy. McWhirter et al. (1998, 2001) found that a potential role of coping efficacy was as a mediator in the relation between barrier perceptions and choice, as Lent et al. (2000) hypothesized. Furthermore, racial/ethnic minority students reported significantly lower coping efficacy than White students for the perceived barriers, which calls for further research attention to the role of coping efficacy in future investigations. On the other hand, Tate et al. (2015) could not find the effect of higher level of coping efficacy on the intentions/behaviors in pursuit of graduate school among a sample of racially diverse college students, and stronger coping efficacy for career barriers was significantly associated with a decrease in perceptions of career barriers only for men with positive dispositional affect.

A number of studies have been conducted to test assumptions and hypotheses associated with SCCT choice model. In general, these studies have supported general tenets of SCCT, providing evidence of its applicability to diverse groups of people empirically, including women of color (Hackett & Byars, 1996), gay and lesbian workers (Morrow, Gore, & Campbell, 1996), persons with disabilities (Fabian, 2000), first generation college students (Garriott, Navarro, Flores, 2017), individuals from lower income background (Flores, Navarro, & Ali, 2017), and racial/ethnic minority populations (Fouad & Kantanmeni, 2013; Sheu, Mejia, Rigali-Oiler, Prime, & Chong, 2016). Comprehensive meta-analyses (e.g., Lent et al., 2018) also have provided additional empirical support for the model across studies.

Although SCCT choice model has been applied to a wide range of career fields, STEM fields are the one of the most active areas of research (Lent, 2013, 2018; Sheu et al., 2010). The role of self-efficacy in relation to math, scientific, and technical tasks were the major focus in some of the early applications, involving middle and high school or college students specifically pursuing engineering and science majors. For example, Lent, Lopez, and Bieschke (1993) found that self-efficacy's role as a mediator in the relationship between past course achievements and academic interests. Specifically, interests were mediated the effects of self-efficacy on intentions in math among their undergraduate sample. Similarly, math self-confidence and abilities were strong predictors of major choice in STEM disciplines among college students (Moakler & Kim, 2014) as well as high school students (Garriott et al., 2014). Specifically, engineering students' choice goals (i.e., persistence intentions) were also examined by scholars (e.g., Flores, Li, & Navarro, 2017).

Outcome expectations have received less attention compared to the other core constructs of social cognitive variables (Fouad & Guillen, 2006). However, given documented inconsistent

results on the role of outcome expectations in the development of expression of interests and goals in STEM, particularly engineering (Flores et al., 2014, Lent et al., 2003; Lent, Brown, Sheu, et al., 2005; Lent, Shue, Gloster, & Wilkins, 2010), scholars have urged further research focusing on outcome expectations. For example, engineering outcome expectations had nonsignificant effects on interests, major choice, academic satisfaction, or goals (Lent et al., 2003; Lent, Lopez, Sheu, & Lopez, 2011; Lent, Singley, Sheu, Schmidt, & Schmidt, 2007; Navarro, Flores, Lee, & Gonzalez, 2014), whereas significant relations were reported with the same variables in other studies (Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; Flores et al., 2014; Lent et al., 2013). Some scholars noted potential issues with measurement issue as well as sample's characteristics (e.g., gender, race/ethnicity) in construct of outcome expectations. Based on this need, Lee and her colleagues (2018) developed the scale for assessing negative outcome expectations in engineering in an attempt to improve measurement of this central SCCT construct with diverse samples. Indeed, Morrow et al. (1996) highlighted the critical role of outcome expectations in the development of interests and goals among individuals from oppressed groups.

A further support was established in the later by scholars, adding additional considerations in the model (e.g., outcome expectations, goals, social supports and barriers). According to Lent et al. (2001), perceived supports and barriers predicted self-efficacy among a sample of college students, which in turn also predicted outcome expectations and interests. Only perceived barriers moderated the relationship between interests and goals, contrary to initial hypotheses by Lent et al. (1994) (i.e., proximal contextual variables only fully mediate the relation between interests and choice goals through self-efficacy, rather than directly related to

interests and choice goals). This finding was also replicated with the examination of SCCT tenets among engineering college students in the U.S. (e.g., Lent et al., 2003).

The relations among person-inputs, background contextual factors, learning experiences, and person-cognitive variables were also investigated. Parental involvement as a background contextual factor predicted career choice as well as the math/science goals among diverse college students (Byars-Winston & Fouad, 2008; Tang, Fouad, & Smith, 1999). Furthermore, socioeconomic status was used as a variable to predict math/science self-efficacy, outcome expectations, and academic aspirations among rural Appalachian high school students (Ali & McWhirter, 2006; Ali, McWhirter, & Chronister, 2005) as well as among Mexican American middle school students (Navarro, Flores, & Worthington, 2007). Engineering samples were also tested by comparing Latinx and White college students (Flores, Navarro, Lee, & Luna, 2014; Flores et al., 2014)

Longitudinal studies have strengthened the empirical support for SCCT hypotheses and extended knowledge in understanding the relationships between core tenets over time. For example, Nauta and Epperson (2003) examined the temporal relationships between science/math/engineering (SME) self-efficacy, outcome expectations, and career choice in a sample of high school female using a 4-year longitudinal design. They found that both math/science ability and SME self-efficacy in high school predicted college SME self-efficacy, and early choice in majoring SME relevant fields in early college predicted later college SME self-efficacy and outcome expectations. With an engineering sample, Lent et al. (2008) also reported that self-efficacy predicted outcome expectations, interests, and goals one semester later among 209 undergraduate students, although some of hypotheses were not supported (e.g., outcome expectations predict self-efficacy). Similarly, persistence intention in engineering was

examined with diverse populations and varied context longitudinally, such as college students in historically Black universities (Lent et al., 2010) and Hispanic serving institutions and predominantly White institutions (Navarro, Flores, Lee, & Gonzalez, 2014; Navarro et al., 2019; Lee, Flores, Navarro, & Kanagui-Muñoz, 2015), exploring group differences based on the intersectionality among different identities (e.g., gender) and environment (HSIs vs. PWIs). The results of these studies showed overall support for the choice model and suggested that self-efficacy served as a temporal precursor of outcome expectations.

Meta analytic studies also have supported hypotheses regarding SCCT person-cognitive variables. According to the most recent research, focusing on STEM fields by Lent and his colleagues (2018), all hypothesized paths were statistically significant in the choice model, except for the path from barriers to outcome expectations. These findings are consistent with Sheu et al. (2010). Lent et al. (2018) also suggested the possibility that supports and barriers may play complementary or compensatory roles in the choice process with a potential mediating role of supports in the relation of barriers to self-efficacy and outcome expectations. Gender and race/ethnicity were also investigated as moderators, and findings showed meaningful gender and racial group differences in core person-cognitive variables (Lent et al., 2018). Most of the differences were in paths that were associated with the two proximal contextual factors (i.e., supports and barriers). Specifically, while a larger negative correlation between supports and barriers was spotted in the racial/ethnic minority samples than in the majority samples. The path from outcome expectations to goals was also stronger in the racial/ethnic minority sample, suggesting potential unique roles of outcome expectations in the career behaviors of individuals who have experienced discrimination and systemic bias (Brown, 1995). Particularly, researchers indicated that the payoffs associated with STEM fields (e.g., chance to support one's family via

attractive salaries and prestige) are likely to boost the STEM motivation of groups that have historically challenges in entering the career paths of high-prestige fields.

In sum, a large body of literature accumulated over time supports the assumptions and hypotheses associated with SCCT choice model. While self-efficacy generally has been proved as a predictor to STEM choice goals, outcome expectations may play a different role depending on sample, as suggested by prior research (e.g., Lent et al., 2018). Given the current study's research questions involving URM students in engineering, therefore, both positive and negative outcome expectations will be included in the hypothesized model. Additionally, very few studies have examined factor based on the interaction between environment and person input within SCCT framework, potentially influencing social cognitive variables (i.e., self-efficacy, outcome expectations, and persistence intention). Given a prior study by Deemer and his colleagues (2014), this might be a necessary piece to understand career development process by the oppressed groups in specific fields. Lastly, the role of coping efficacy in career development also has not been clear with a limited prior research. Considering that coping efficacy may buffer the detrimental impact of hindered circumstances, especially for URM students, it might be important to clarify its effect in one's career development.

Institutional Context as a Proximal Affordance

Given that contextual factors (i.e., PWIs and MSIs) are considered as a major variable to understand URM students' persistence intentions in engineering disciplines in the current study, it is valuable to define terms and its role in career development among URM students who pursue STEM majors.

According to Li and Carroll (2007), Minority-Serving Institutions (MSIs) are defined by legislation or by the proportion of minority student enrollment in them. Examples of MSIs

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established by legislation include Historically Black Colleges or Universities (HBCUs), Tribal

Colleges or Universities (TCUs), and Asian American and Pacific Islander Serving Institutions

(AAPISIs). In contrast, Hispanic-Serving Institutions (HSIs) are a type of MSI based on the

percentage of minority student enrollment. The number of institutions in these groups vary from

year to year based on the enrollment of students in their respective minority groups. Institutions

that meet the federally designated criterion (i.e., public and private nonprofit institutions whose

undergraduate, full-time equivalent student enrollment is at least 25% Hispanic) are eligible to

apply for HSI status.

　　MSIs enroll a substantial fraction of underrepresented minority undergraduates (NSF,

2019). Scholars have reported their effectiveness in facilitating the educational attainment of

URM students in general (Contreras, Malcom, & Bensimon, 2008; Harmon, 2012; Laird,

Bridges, Morelon-Quaninoo, Williams, & Holmes, 2007; Palmer & Gasman, 2008), and

specifically in STEM education (Contreras et al., 2008; Perna et al., 2009). For example, in 2015,

HBCUs and HSIs awarded respectively 16% of the 54,000 bachelor's degrees earned by Black

U.S. citizens and permanent residents and 34% of the 79,000 bachelor's degrees earned by

Hispanics in STEM disciplines. The proportion of MSIs that produce URM students in STEM

fields has consistently increased, proving MSIs' role in increasing STEM access and success

among URM students. Considering MSIs significant role of improving the participation in and

outcomes of postsecondary education for URM students (Wright, 2004), scholars started paying

more attention on the role of these institutions in cultivating URM students in STEM

professionals. According to National Academies of Science, Engineering, and Medicine (2019),

MSIs provide a sensitive climate that consists of peer support, mentoring, role modeling, cultural

relevant curricula, and that places an emphasis on teaching—all of which play a significant role

in the educational outcomes among URM students in MSIs (Contreras et al., 2008; Palmer, 2010; Palmer, Davis, & Thompson, 2010; Palmer & Gasman, 2008), specifically in STEM (Contreras et al., 2008; Perna et al., 2009).

On the other hand, Predominantly White Institutions (PWIs) is used to describe institutions of higher learning in which Whites account for 50% or greater of the student enrollment. Given the understanding about the benefits of diversity in educational setting, most institutions are grappling with ways to increase the retention and persistence of URM students in STEM regardless of their institutional types (PWI; Harper, 2009; Hurtado, Milem, Clayton-Pedersen, & Allen, 1999; Palmer, Maramba & Holmes, 2011). Consistent reports indicate that the institutional climates of PWIs are likely to serve as an obstacle to the academic growth and social involvement of URM students in general, and STEM in particular. Scholars have noted URMs experiences on the campuses of PWIs as chilly, alienating, unsupportive, and perpetuators of racial microaggressions (Smith, Yosso, & Solórzano, 2007; Solórzano, Ceja, & Yosso, 2000; Solórzano & Yosso, 2002). A supportive and engaged faculty is critical to the success of college students in general and STEM specifically (Cole & Espinoza, 2008; Fries-Britt, Burt, & Franklin, 2012) as the climates and cultures of PWIs and departments within these institutions are likely to pose several challenges for URM students. Specifically, students of color at PWIs face a significant number of barriers associated with racial discrimination and stereotyping (Museus, Palmer, Davis, & Maramba, 2011; Hurtado, Cuellar, Guillermo-Wann, & Velasco, 2010; Solorzano et al., 2000), resulting premature drop-out in STEM education (Bonous-Hammarth, 2000; Griffith, 2010). These barriers include negative stereotypes about URM students (Figueroa & Hurtado, 2013), implicit bias (Moody, 2004; Turner, González, & Wood,

2008), and established environmental culture(s) and traditions that reflect White culture (Harper, 2012; Zambrana et al., 2015).

Indeed, the moderating effects related to intersections of race/ethnicity X institution type were reported by scholars. According to study on engineering students' academic persistence by Navarro et al. (2019), there were no differences across White students (i.e., White in PWIs vs. White in HSIs) as well as racial/ethnic differences within the same institution type (e.g., Latinx vs. Whites in PWIs). However, institutional differences for Latinx engineering students were reported. Specifically, positive and stronger relations between interests and intended persistence as well as between social cognitive constructs (i.e., self-efficacy, outcome expectations) and academic satisfaction were stronger for Latinx at PWIs than for HSIs. Whereas the link from outcome expectations to academic satisfaction was not significant for Whites at HSIs, positive and significant links were uncovered for all other racial/ethnic X institution groups. This finding suggests the needs for tailored interventions for Latinx at PWIs that help to enhance self-efficacy and build interests in engineering activities, ultimately may assist their persistence at PWIs.

In the current study, URM students who pursue STEM majors from both PWIs and MSIs will be targeted to understand the effects of contextual factors on their personal-cognitive factors (i.e., self-efficacy, coping efficacy, and stigma consciousness). Specifically, HBCUs, Black-serving, non-HBCUs institutions, HSIs, and American Indian-serving (i.e., TCUs) will be included under the category of MSIs. AAPISIs are excluded, given the over-representation of Asians in STEM fields.

Stereotype Threat

One possible explanation that has been offered for the disproportionate number of bachelor's degrees in engineering awarded to URM students is racial stereotype threat.

According to stereotype threat, it possible that URM students worry so much about disconfirming a negative stereotype about their race/ethnicity in engineering courses or majors that it affects their academic achievement and ultimately their willingness to remain in an engineering major and career (Owen & Massey, 2011). Given that URM students may feel higher levels of stereotype threat in the environment where having less number of other URM students, it is important to explore how stereotype plays a different role in different types of institutions. Thus, reviewing past studies about stereotype threat and its potential influences within specific contexts among URM students in engineering will allow us to understand their experiences as marginalized groups in engineering.

When people are reminded that they belong to a group associated with weaknesses in evaluative domains, they tend to perform more poorly across a broad range of domains, from playing chess to intellectual ability tests (Hall, Schmader, & Croft, 2015; Spencer, Logel, & Davies, 2016; Whaley, 2017). Every individual is potentially vulnerable to this threat. White people struggle athletically (Perchot, Mangin, Lacassagne, & Castel, 2017; Smith & Martiny, 2018), Black people struggle academically (e.g., Steele & Aronson, 1995), women struggle mathematically (e.g., Picho & Schmader, 2018) and spatially (McGlone & Aronson, 2006). These stereotype threat situations were introduced and tested by Steele and his colleagues (1995, 1997).

According to Steele's (1997) original conceptualization, stereotype threat is predicted to be most prevalent in certain situations that bring to mind one's membership in a negatively stereotyped group or that may raise the possibility that one will be evaluated through the lens of a stereotype. Thus, merely being a member of a stereotyped group surrounded by others who are expected to be more successful at a task can be sufficient to elicit stereotype threat. Although

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there have been robust effects with groups of different identities (e.g., race/ethnicity, sex, age) and other dependent variables (Nguyen & Ryan, 2008), it is a logical assumption that individuals would not experience stereotype threat if people are unaware that a negative stereotype exists about their own group's performance in a certain domain. For example, first-generation Black immigrants in the U.S. have little exposure to the cultural stereotypes denigrating Blacks' intelligence and show less evidence of stereotype threat (Deaux et al., 2007), whereas elementary school students who are aware that their group is stigmatized as academically inferior showed lower level of academic performance in a task they thought was diagnostic of intellectual ability (McKown & Weinstein, 2003).

These studies demonstrated a potential mechanism for how stereotype threat may work along with the cultural factors, emphasizing a key role in activating stereotype threat and the resulting decrease in performance. Although some level of awareness about the negative stereotype is necessary for experiencing stereotype and endorsing a stereotype can exacerbate the effect, this does not suggest that the stereotype needs to be internalized (Steele, 1997). In some circumstances, knowing that others view you or your group through the lens of negative stereotypes would be enough to provoke feeling of threat (Shapiro & Neuberg, 2007). Furthermore, Steele (1997) indicated that stereotype threat will be most acutely experienced by "those who are at the vanguard of their group." He further explained that people who are the most invested in doing well in a domain in which their group is stereotyped negatively are likely to experience the fear of being categorized falsely. This fear often can increase one's motivation to excel, which does not necessarily translate into better performance, even debilitating the fear for challenging and complex tasks. Considering the complicated interactions between

circumstances and stereotype threat, the next section will discuss the antecedents and consequences of stereotype threat in a broader view.

Antecedents and consequences of stereotype threat. Ample research has utilized laboratory experiments to understand inducing/reducing threat, since Steele and Aronson's (1995) seminal experiments. As suggested in the previous section, the accumulated findings demonstrated that for stereotype threat effects to occur, some aspect of the situation needs to activate a negative stereotype about one's group, and that threat cue produces the negative downstream consequences. In other words, the presence of threat cue prompts states of heightened cognitive and physiological vigilance, and people that encounter those threat cues feel decreased feelings of belonging, which is likely to less participate in a setting (Murphy, Steele, & Gross, 2007). A review of stereotype threat (Lewis & Sekaquaptewa, 2016) categorized threat cues into three different groups, emphasizing the broader outcomes of stereotype threat beyond test performance: (1) situations in which members of one's group are underrepresented in a domain (Murphy, Steele, & Gross, 2007; Sekaquaptewa & Thompson, 2002; Sekaquaptewa & Thompson, 2003); (2) situations in which physical objects suggest that members of one's group do not belong in a domain (e.g., Cheryan, Plaut, Davies, & Steele, 2009); and (3) situations in which members of one's group are treated negatively, sometimes manifesting as overt discrimination or as microaggressions that people subtly derogate members of one's group (LaCosse, Sekaquaptewa, & Bennett, 2016; Sue, 2010).

In addition to impaired performance, other important outcomes have been documented as the effects of stereotype threats. Research have shown that stereotype threat cues can diminish sense of belonging in and identification with an academic field (Cheryan et al., 2009; Smith, Brown, Thoman, & Deemer, 2015) and lower performance expectancies on an upcoming test

(Sekaquaptewa & Thompson, 2002; Thomspon & Sekaquaptewa, 2003). These researchers noted that these outcomes may also undermine interest and persistence in stereotype relevant domains. The effects of stereotype threat also extend beyond academic settings to include the quality of doctor-patient interactions, leading to negative health outcomes for patients (Burgess, Warren, Phelan, Dovidio, & Van Ryn, 2010), athletic performance (Krendl, Gainsburg, & Ambady, 2012; Stone, Lynch, Sjameling, & Darley, 1999), driving performance (Yeung & von Hippel, 2008; Lambert et al., 2016), and workplace success and well-being (Gupta, Goktan, & Gunay, 2014; Von Hippel, Sekaquaptewa, & McFartane, 2015). Researchers also documented stereotype threat's influence on the intergroup relations, particularly interracial interactions in the United States. Specifically, the awareness of these stereotypes can lead to uncomfortable and insincere interactions in which Blacks are concerned about being perceived in terms of Black stereotype (Najdowski, Bottoms, & Goff, 2015) and Whites are concerned with appearing a racist (Richeson & Shelton, 2007), which is likely to decrease individuals' motivation to have more interracial interactions in the future. Given the diverse composition of current U.S. population, this effect of stereotype threat is detrimental for the larger society.

The mechanisms underlying stereotype threat. For several years, the mechanisms that stereotype threat effects cognitive performance dominated the literature. However, inconsistent or unconvincing mediators of the effect between stereotype threat and performance have plagued research. Therefore, in this section, the mechanism underlying stereotype threat will be discussed using the *integrated process model* of stereotype threat (Schmader, John, & Forbes, 2008).

The integrated process model focuses on the role of working memory. Earlier research identified deficits in working memory's role in lower performance observed in situations that cue negative stereotypes. The working memory capacity is likely to be a candidate as a domain-

general cognitive mechanism that could be undermined by padding process due to stereotype threat. Indeed, both women and minorities exhibited lower levels of working memory capacity when they believe that group differences in ability will be diagnosed in the context (Schmader & Johns, 2003; Beilock, Rydell, & McConnell, 2007). These researchers identified this as cognitive fatigue effects due to stereotype threat. The integrated process model identified several pathways by which situational reminders of being stereotyped negatively can impair these executive functions: (a) physiological stress response, (b) metacognitive performance monitoring, (c) suppression processes, and (d) mere effort.

Contrary to earlier speculation that stereotype threat might be a manifestation of an automatic priming effect (Wheeler & Petty, 2001), more evidence has suggested that an increased *physiological stress response* in situations cue stereotype threat when one performs under the burden of a negative stereotype. Specifically, the process of physiological stress response starts from the moment the body realizes the presence of the stressor (e.g., social evaluative threat), followed by the sending of signals to the brain, and to the specific sympathetic and hormonal responses (e.g., cortisol) to eliminate, reduce, or cope with stress. However, the link between the direct physiological response to stress and lower performance has yet to be empirically documented. A second mediational pathway to lower performance is *an increased tendency to explicitly monitor one's behavior and the situation.* It is postulated that dueling and imbalanced cognitions activate this more conscious and deliberative mind-set, along with the desire to disconfirm the more negative expectation (Seibt & Forster, 2004). For example, those confronted with the possibility of being stereotyped become more vigilant to social cues of rejection (Inzlicht, Kaiser, & Major, 2008) or performance errors (Forbes, Schmader, & Allen, 2008). By eliciting metamonitoring processes, the state of self-uncertainty may fuel a need to

appraise the situation in light of the activated stereotype, shifting focus from the task to oneself as a performer of the task and the resulting intrusive thoughts of worry or self-doubt. Clearly, this can be directly harmful for performance on complex cognitive tasks (Cadinu, Maass, Rosabianca, & Kiesner, 2005; Steele & Aronson, 1995).

The integrated process model extends to the more interrelated set of mechanisms as well, which are *a suppression process* and *mere effort*. According to the model, the combination of self-doubt and difficulty in performing the task increases the level of anxiety, which further aggravates the effects of threat (Johns, Inzlicht, & Schmader, 2008). Ultimately, this anxiety impairs the performance via attempting to suppress unwanted negative thoughts and emotions (e.g. anxiety) cued by one's stereotype status. These avoidance attempts were demonstrated to lower working memory capacity by avoiding the experience or manifestation of anxiety in a threatening context, particularly among women and minorities (Johns et al., 2008; Logel, Iserman, Davies, Quinn, & Spencer, 2009). Furthermore, individuals' motivation to disconfirm the stereotype is likely to exert more effort on the task at hand, facilitating the rigid strategy rather than approaching the problem in a flexible way (Jamieson & Harkins, 2007; 2009). Stereotype suppression is likely to predict this lack of flexibility in problem solving, as one may be experiencing cognitive load due to other processes (e.g., avoidance attempts).

Stereotype Threat in STEM. In STEM fields, gender stereotype threat and its negative influences on women's performance, persistence, and belonging in the fields has been investigated (e.g., Murphy, Steele, & Gross, 2007; Spencer, Steele, & Quinn, 1999). The negative environment that women experience has been considered as one factor that diminishes women's intentions to continue in STEM (e.g., Beller & Gafni, 1996; Eccles & Blumenfeld, 1985). For example, Wong and Fraser (1996) documented that students who experience a

"chilly" climate in a chemistry lab had more negative attitudes toward the field of chemistry, which possibly influences on students' motivation, learning, and academic performance (e.g. Church, Elliot, & Gable, 2001). Perceived gender stereotype in STEM can be increased via environmental cues, including absence of women in the setting (Stout, Dasgupta, Hunsinger, & McManus, 2011; Murphy et al., 2007; Sekaquaptewa & Thompson, 2002, 2003) and the perception that women are disfavored in the settings (Beller & Gafni, 1996; Catsambis, 1995; Eccles & Blumenfeld, 1985). Many scholars also focused on women's sense of belonging in the field as a determinant of their decreased interest in STEM (e.g., Cheryan et al., 2009; Murphy et al., 2007; Thoman, Smith, Brown, Chase, & Lee, 2013; Walton & Cohen, 2007). Murphy and Taylor (2012) suggested that environmental cues that indicate that women's contributions to STEM are valued can trigger social identity threat (Steel, Spencer, & Aronson, 2002). The positive association between the levels of belonging and interests in STEM has been well documented among women, especially among those who were motivated to preserve their self-esteem (Thoman, Arizaga, Smith, Story, & Soncuya, 2014).

Stereotype threat's influence on URM students in STEM has been an area of iniquity to explain the scarcity of URM students STEM majors. Previous research has often focused on the academic deficits of URM students (e.g., Stangor & Sechrist, 1998). However, educational statistics did indicate that a considerable amount of the racial disparity in initial STEM interest can be attributed to inequalities in primary and secondary education, as URM students have different educational opportunities than White students, including teacher quality, curriculum, class size, and school size that correlated with academic performance (Darling-Hammond, 2004a). A variety of explanations have been advanced to account for racial gaps in academic performance in general, including oppositional identity (Fordham & Ogbu, 1986) and different

level of resources across groups (Massey, Amin, & Thrift, 2003). Among these explanations, racial stereotyping and discrimination have also been proposed as barriers for the entry, retention, and success of URM students in STEM (Grossman & Porche, 2014).

African American students are generally stereotyped in ways that are incongruent with perceived success in the STEM fields. For example, perceptions that African Americans are less competent than White and Asian students (Blaine, 2013) may potentially lead a low retention to major in STEM among African Americans students (Beasley & Fisher, 2012; Kellow & Jones, 2008) as well as reports that these students are "finding it hard to position themselves as properly scientific" (Carlone & Johnson, 2007). Torres and Charles (2004) found silent tension between African American and White American students on the campus. According to their findings, while White students consistently held racial stereotypes of African Americans as unqualified for postsecondary education, over 75% of African American participants believed that most White student were the recipients of preferential treatment and incapable of being accepted on their own academic merits. Latinx students are also stereotyped in STEM as less competent and lower in STEM ability than Whites and Asians (Blaine, 2013; Jimeno-Ingrum et al., 2009) and as a group that does not value formal education (Valencia & Black, 2002). For example, a study showed that Latinas' worry about how professors stereotype the academic ability of their racial/ethnic group was significantly and negatively associated with their college GPA (Valencia & Black, 2002). Another study reported lower level of feeling of belongingness by Latinx students in middle school as they were more concerned about being judged on the basis of their race at school (Sherman et al., 2013).

Prior Research Models regarding Stereotype Threat. Most research related to stereotype threat in academic domains has been conducted on a small scale as the dominant

research paradigm is to induce stereotype threat in a stereotyped group within a lab setting. Specifically, researchers would give a test or task, make the stereotype salient depending on the task, and test the effect of stereotype threat by ensuring the group is isolated in the environment. Because of the research designs used in prior stereotype threat studies, it has been difficult to conduct large scale, field research to test these assumptions. Steele and Aronson (1995), who first introduced the construct of stereotype threat, also did experimental testing by giving the same GRE-type verbal questions under one of two conditions: diagnostic of ability or non-diagnostic of ability. After accounting for SAT verbal scores, lower scores were reported in the diagnostic condition than in the non-diagnostic condition for Black studies, whereas there was no difference for White students. Likewise, the majority of threat-inducing studies consist of a single laboratory session, and cognitive abilities such as practice SAT or GRE problems, other math problems, or vocabulary tests were used to test threat effect. Another type of research has frequently examined the short-term and long-term effects of threat-reducing interventions, such as delaying collection of demographic information (e.g., Danaher & Crandall, 2008) and posting images of role models (e.g., Blanton, Crocker, & Miller, 2000). Most of these studies have not examined the effect of stereotype threat in authentic outcomes (e.g., grades or retention) in natural academic settings. Therefore, the current study aims to complement experimental work in this area by examining URM students' perceptions of these social psychological factors.

Stigma Consciousness

To capture the effect of stereotypes in real-world situations, researchers have used a proxy for stereotype threat: *stigma consciousness*. Stigma consciousness is a schema of anticipation that others will stereotype a person regardless of that person's behavior (Pinel, 1999). Brown and Pinel (2003) found that women high in stigma consciousness performed worse

than women who were less stigma consciousness when gender stereotypes were made accessible prior to taking a difficult math test. Indeed, URM students who are high in stigma consciousness tend to perceive greater discrimination against themselves and members of their group (Pinel, 1999) and are more vigilant to race-related threats (Major & O'Brien, 2005). As a result, individuals who are high in stigma conscious (e.g., racial/ethnic minority) tend to report increased psychological distress, greater susceptibility to stereotype threat, and lower self-esteem (Brown & Lee, 2005; Pinel, Warner, & Chua, 2005), especially in the context of ambiguous discrimination (Wang, Stroebe, Dovidio, 2012). With respect to racial/ethnic minorities, stigma consciousness is associated with greater evaluative concerns, an increased threat vigilance, and a higher level of psychological distress (Burgess, Molina, Bhandari, & Dibartolo, 2018; Major, Mendes, & Dovidio, 2013).

Given that URM students in different institutional environments might experience different levels of discrimination, which may influence the development of stigma consciousness as an URM group in STEM fields, I conceptualize these two proxies for stereotype threat (i.e., stereotype vulnerability and stigma consciousness) as constructs that represent the perceived experiences of URM students in their academic environments.

Intersectionality

Intersectionality is a theoretical approach that simultaneously considers multiple categories of identity, difference, and disadvantage, such as gender, race/ethnicity, social class, sexual orientation, disability, and religion (Cole, 2009). This is a well-established framework for examining the complex ways in which multiple systems of oppression deeply intertwine to influence experiences and opportunities among individuals and groups (Bowleg, 2012; Cho, Crenshaw, & McCall, 2013; Collins, 2015; Museus & Griffin, 2011; Warner & Shields, 2013).

This framework guides us to understand how our experiences and the social identities that inform people are connected to systems of power, privilege, and oppression within various social, political, economic, environmental, and historical contexts (Crenshaw, 1991).

Because of its capacity to situate and understand individual and group experiences within a larger, systemic context, intersectionality has become a widely used framework in law, humanities, and the social sciences and continues to grow in popularity. However, Metcalf and colleagues (2018) pointed out the scarcity of the research about the intersectionality in STEM or STEM workplaces, noting that only 4.5 % of approximately 38,600 scholarly publications in STEM that have used the term intersectionality over the past 10 years. They also noted the significant role of contexts in shaping students experiences when it comes to STEM inclusion and participation, suggesting that some elements of social identities may be more salient in certain contexts than in others. As a result, they recommended to analyze data from an intersectional approach, even when the sample size is small as well as to remember the systemic and contextual focus, which this study focused on developing research questions.

CHAPTER III

METHODS

Participants

A total of 298 engineering students were recruited for the study. Twenty-one cases that identified as Asian/Asian American or White were excluded, given the goals of the current study. Cases with more than 20% missing data were deleted (Peng et al., 2006). Little's MCAR test showed that data were missing completely at random ($\chi2 = 688.410$, $df = 708$, $p = .694$), so missing data were replaced using the MICE package (van Buuren & Groothuis-Oudshorn, 2011) in R with the use of auxiliary variable to help impute missing data. The Mahalnobis distance test result showed that three cases violated multivariate normality assumption and thus were deleted, resulting in a total of 265 cases. According to sample size recommendations for mediation analysis (Weston & Gore, 2006) and moderated mediation analysis (Aiken & West, 1991), our sample size and estimated parameters had enough power to detect moderate effect sizes.

The participants in the study ranged in age between 18 and 36 with a mean age of 22.1 ($SD = 4.16$). More than half of the participants were women ($n = 138$, 52.1%), 47.2% ($n = 125$) identified as male, and two indicated as "other." Of these participants, 123 identified as Hispanic or Latinx (46.4%), 90 as African American or Black (34%), 43 as multiracial/ethnic (16.2%), 4 as Native American (1.5%), and 5 as "other" (1.9%). The majority of the participants identified as heterosexual (n = 228, 86%), followed by bisexual ($n = 21$, 7.9%), gay ($n = 5$, 1.9%), lesbian ($n = 4$, 1.5%), and "other" ($n = 7$, 2.6%). By generational status, 47.9% ($n = 127$) identified as second generation, 20.8% ($n = 55$) as first generation, 18.1% ($n = 48$) as fifth generation, 6.8% ($n = 18$) as third generation, and 6.4% ($n = 17$) as fourth generation.

Most participants identified as undergraduate students, and approximately a third of the participants were in their senior year ($n = 78$, 29.5%), followed by juniors ($n = 62$, 23.6%), sophomores ($n = 46$, 17.7%), first year students ($n = 23$, 8.7%), and "other" ($n = 4$, 1.4%). There were graduate students who participated the study who were pursuing a master's degree in engineering ($n = 25$, 9.7%) as well as a doctorate degree in engineering ($n = 24$, 9.4%). Participants reported their major as computer engineering ($n = 59$, 22.6%), mechanical engineering ($n = 55$, 20.9%), biomedical engineering ($n = 29$, 11.0%), civil engineering ($n = 28$, 10.6%), electrical engineering ($n = 24$, 9.0%), aerospace engineering ($n = 13$, 4.7%), industrial engineering ($n = 11$, 4.0%), chemical engineering ($n = 11$, 4.0%), material science and engineering ($n = 5$, 2.0%), architectural engineering ($n = 3$, 1.0%), manufacturing engineering ($n = 3$, 1.0%), nuclear and radiological engineering ($n = 2$, 0.7%), engineering management ($n = 2$, 0.7%), and "other" (e.g., engineering physics, energy system engineering)($n = 20$, 7.6%).

Procedure

Approval to collect data was secured with the Institutional Review Board and the study was conducted in compliance with the approved protocol. Participants were recruited through announcements sent to engineering students from engineering colleges at large U.S. universities. Institutional type and the number of existing engineering students were considered; examples of universities that assisted in the data collection included Arizona State University, Virginia Tech, Pennsylvania State University, University of Missouri, University of Florida for predominantly White institutions; Florida International University, California State University, Long Beach, California State University, Los Angeles, University of New Mexico, Texas A&M University—College Station for Hispanic Serving Institutions (HSIs); and University of South Florida, North Carolina A&T University, Prairie View A&M University, Southern University and A&M

College for historically Black colleges and universities (HBCUs). Student members of engineering professional organizations, such as National Society of Black Engineers (NSBE), Society of Hispanic Professional Engineers (SHPE), and American Indian Science and Engineering Society (AISES), were also invited to participate. Email announcements included information regarding the purpose of the current study and the scope of the study, the eligibility criteria for participation, potential benefits and risks, information concerning privacy and confidentiality, and researchers' contact information. Participants who completed the study were given the option to enter a raffle for 45 prizes by providing their email addresses. Incentives included 40 $10 and 5 $20 Amazon.com gift cards.

Measurement

Demographic variables. Participants completed a brief demographic questionnaire with questions regarding their age, race/ethnicity, gender, sexual orientation, year in school, major, and generational status (See Appendix C).

Engineering Self-Efficacy. Bandura (1997) suggested that academic behavior is best predicted by measures that tap multifaceted aspects of self-efficacy, such as perceived ability to attain academic milestones. Accordingly, academic self-efficacy among engineering students was assessed using the Engineering Self-Efficacy Scale (ESE; Lent, Brown, et al., 2005), a four-item measure adapted from the Self-Efficacy for Academic Milestones Scale (Lent, Brown, & Larkin, 1986). The original measure assessed students' confidence in their ability to successfully perform a variety of academic tasks in science and engineering majors. The modified version that was used in the current study assesses only perceived capabilities for performing well in engineering academic requirements. Participants were asked to indicate their belief in their academic abilities to perform well in engineering (e.g., "excel in your engineering major over the

next semester"). For each item, confidence ratings were obtained on a 10-point Likert-type scale ranging from 0 (*completely unsure*) to 9 (*complete sure*), indicating high levels of engineering self-efficacy by high averaged scores. Coefficient alpha scores ranging from .90 to .92 have been reported for this measure with engineering college student samples from racially diverse background (Flores et al., 2014; Lent, Brown, et al., 2005; Lent et al., 2007). Total engineering self-efficacy scores correlated positively with positive engineering outcome expectations (Lent, Brown, et al., 2005; Lent et al., 2007), engineering interests and goals (Lent, Brown, et al., 2005), and engineering goal progress and engineering academic satisfaction (Lent et al., 2007), consistent to theory-driven hypotheses. In this study, Cronbach's alpha for scale score on Engineering Self-Efficacy was .89.

Engineering Outcome Expectations. A variety of outcomes that participants might expect from obtaining a college degree in engineering will be assessed in two dimensions: positive and negative outcome expectations. The Positive Engineering Outcome Expectations (POE; Lent et al., 2003) was used to measure of positive outcome expectations (e.g., "get respect from other people"). Items were answered using a 10-point Likert scale ranging from 0 (*strongly agree*) to 9 (*strongly agree*). Scores were averaged, with high scores reflecting high positive outcome expectations related to graduating in engineering. Scores have been positively correlated with engineering interests, social support, and goals (Lent et al., 2003, 2005, 2008). Previous studies have also reported coefficient alphas ranging from .89 to .91 for this measure (Flores et al., 2014; Lent et al., 2003, 2005).

Negative aspects of outcome expectation from obtaining a college degree in engineering were assessed using the Negative Outcome Expectations Scale-Engineering (NOES-E; Lee, Flores, Navarro, & Suh, 2018). Participants responded to items using a Likert scale ranging from

0 (*strongly disagree*) to 9 (*strongly agree*). The NOES-E is composed of four subscales: cultural-related stressors, personal life and work balance, job characteristics, and social costs. Example items include "graduating with a BS degree in Engineering will likely result in high levels of stress due to a demanding work environment that affects my home life." Construct validity of the NOES-E was supported through a positive correlation with a measure of engineering barriers and negative correlations with measures of engineering self-efficacy, academic satisfaction, intended persistence, supports, and positive outcome expectations (Lee et al, 2018). Previous research with Latinx and White engineering students reported a Cronbach's alpha of .94 for this measure (Lee et al, 2018). In this study, the Cronbach's alpha for scores on Positive and Negative Outcome Expectation in Engineering were .89 and .92, respectively.

Engineering Persistence Intentions. The Engineering Persistence Intentions (EPI; Lent et al., 2003) was used to measure students' level of persistence intentions in engineering. The EPI is a 4-item measure of academic persistence intentions in engineering (e.g., "I am fully committed to getting my college degree in engineering"). Participants responded to items using a 5-point Likert scale ranging from 1 (*strongly agree*) to 5 (*strongly agree*). High scores indicate strong intentions to pursue an engineering degree. EPI scores were positively correlated with engineering self-efficacy, interests, positive outcome expectations, and actual verified persistence (Lent et al., 2003, 2013), and previous research with samples of engineering students have yielded internal consistency values ranging from .87 to .95 (Lent et al., 2003, 2005, 2008; Navarro et al., 2014). The Cronbach's alpha for Persistence Intentions in current study was .85.

Racial/Ethnic Stigma Consciousness. To assess individual differences in ethnicity-based stigma consciousness, the Stigma Consciousness Questionnaire -Race (SCQ-R; Brown & Lee, 2005; Pinel, 1999) was used. The SCQ-R differs from the original nonrace specific SCQ in

that it does not explicitly mention a particular stigmatized group (e.g., women), but instead points to race/ethnicity in general (e.g., My ethnicity influences how other people interact with me; Brown & Lee, 2005). Participants responded to the 10-item of SCQ-R on a 7-point Likert type scale ranging from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*). In a study conducted with female undergraduates, Pinel (1999) found evidence for the convergent and discriminant validity and the test-retest reliability of the SCQ related to female stigmatized identity. The scale also had high internal consistency (α = .72) with and maintained significant positive correlations with measures of group and personal discrimination, suggesting high construct validity. The Cronbach's alpha for SCQ-R in current study was .85.

    Coping Efficacy. Coping efficacy of race/ethnicity stigma in college was measured with the adapted version of Coping with Barriers (CWB) scale (Luzzo & McWhirter, 2001). The original scale was used to measure college students' efficacy for coping with barriers related to their career and educational goals. The present study used only the relevant items that may be impacted by students' level of stigma around their own race/ethnicity within Education-Related Barriers subscale (12-items) as well as Career Barriers subscales (4-item). Respondents were asked to "Please rate your degree of confidence that you could overcome each of the potential educational barriers listed below." Using a Likert-type scale ranging from 1 (*not at all confident*) to 5 (*highly confident*), participants rated items such as "Not being prepared enough," "Lack of support from friends," "Negative comments about my racial/ethnic background [insults, jokes]." Total scores were summed and divided by the number of items, with low scores indicating less perceived ability to overcome barriers (i.e., less coping efficacy). Luzzo and McWhirter (2001) supported the validity of the CWB through parallel assessment of perception of barriers. Subsequent studies using the CWB scale have support convergent validity with positive

relationships among related self-efficacy and support variables as well as discriminant validity with perception of barriers and social status such as college women, first-generation and low-income, and Native American postsecondary students respectively (Lopez & Ann-Yi, 2006; Tate et al., 2015; Thompson, 2013). The test-retest reliability for the scale was obtained over a two-month period and demonstrated moderate stability with a coefficient of 0.49. Luzzo and McWhirter (2001) reported an initial alpha reliability of 0.93 and 0.88 for the Educational subscale and Career-Related Barriers, respectively. For the current study, averaged score of CWB in career and education was used. Reliability of the items from the CWB in current study was high, evidenced from alpha of .91.

Research Design

The hypothesized model was tested to examine the fit of the data to the model using R. Several fit indices were used to evaluate the fit of hypothesized and alternative structural models (Martens, 2005). Specifically, the indices that were used to determine the fit of the data were the Tuker-Lewis index (TLI), the comparative fit index (CFI), the root of means square (RMSEA), and the standardized root mean square residual (SRMR). A cutoff of RMSEA of .06 to .08 is considered to be good, .08 as mediocre, and above .10 as unacceptable (Hu & Bentler, 1999). As for the SRMR, less than .05 is considered a well-fitting model but .08 is deemed acceptable (Diamantopoulous & Siguaw, 2000; Hu & Bentler, 1999).

Model A was an indirect effects model and included indirect effects of racial/ethnic stigma consciousness on persistence intention through self-efficacy. Model B was a direct effects model with direct paths from racial/ethnic stigma consciousness to persistence intention. It was hypothesized that Model A would provide a better fit to the data given the results of prior

research (Lent et al., 2001; Lent et al., 2003; Lent et al., 2010). Mediator and moderator

hypotheses were also tested in the present study.

Results

Missing Data and Data Screening

The data were first screened at the item level. Following guidelines from Peng et al.

(2006), cases that had more than 20% missing data were removed. Little's MCAR test showed

that data were missing completely at random ($\chi2$ = 688.410, *df* = 708, *p* = .694), so missing data

were replaced using the MICE package (van Buuren & Groothuis-Oudshorn, 2011) in R with the

use of auxiliary variable to help impute missing data. The Mahalnobis distance test result showed

that three cases violated multivariate normality assumption and thus were deleted. Examination

of skewness and kurtosis statistics suggested that persistence intentions was negatively skewed

(skewness = -3.425). Therefore, a reflection and square root transformation was conducted on

persistence intention scores. Follow-up tests indicated that data met assumptions of normality,

linearity, and homeoscedasticity. After data screening, a total of 263 cases were used for study.

Plan of Analysis. All constructs in the present study were measured using observed

variables and statistical analyses were conducted using R statistical package and the maximum

likelihood (ML) estimation method. To determine adequacy of model-to-data fit, the

comparative fit index (CFI), Tucker-Lewis Index (TLI), Incremental Fit Index (IFI), root mean

square error of approximation (RMSEA), and standardized root-mean-residual (SRMR) were

used. CFI and TLI values greater than .90 and SRMR values of .05 or less indicate good fit. In

addition, RMSEA values less than .05 indicate good fit, .08 – .10 indicates acceptable fit, and

greater than .10 indicates poor fit (Browne & Cudeck, 1993). In addition to these guidelines,

sample size and model complexity should be considered when making judgments based on

absolute fit indices (Weston & Gore, 2006). The Aikake Information Criterion (AIC) was used to

make model comparisons, as the models were non-nested. Generally, lower AIC values indicate improved model-to-data fit (Kline, 2016).

The study's main hypotheses were examined using path analysis. The hypothesized (Model A) and alternative (Model B) structural models including racial/ethnic stigma consciousness, coping efficacy, self-efficacy, positive/negative outcome expectations, persistence intention in engineering were examined. The hypothesized model (see Figure 1) included indirect effects from racial/ethnic stigma consciousness to persistence intention in engineering through engineering self-efficacy, whereas the alternative model (see Figure 2) included direct effects from racial/ethnic stigma consciousness to engineering persistence intention. Furthermore, the moderating effect of coping efficacy on the relationships between racial/ethnic stigma consciousness and engineering self-efficacy as well as positive/negative outcome expectations in engineering were examined. These path models were estimated using maximum likelihood estimation and bootstrapped standard errors using R software. A bootstrapping procedure was used to test the significance of the total and indirect effects and the differences in these effects across levels of the moderator variables with 1000 bootstrap samples. The 95% confidence intervals for the coefficients calculated by bootstrapping methods were considered statistically significant if the confidence intervals did not include zero. Model fit was assessed using the recommended fit indices for SEM. The alternative model was assessed using the chi-square difference test in the case of nested models, descriptive comparisons of fit indices, and the Aikake information criterion (AIC). Statistically significant chi-square difference tests and AIC value differences of 10 or more have been recommended as indicators of significant differences in model fit, with lower AIC values representative of better fit to the data (Kline, 2005; MacCallum & Austin, 2000).
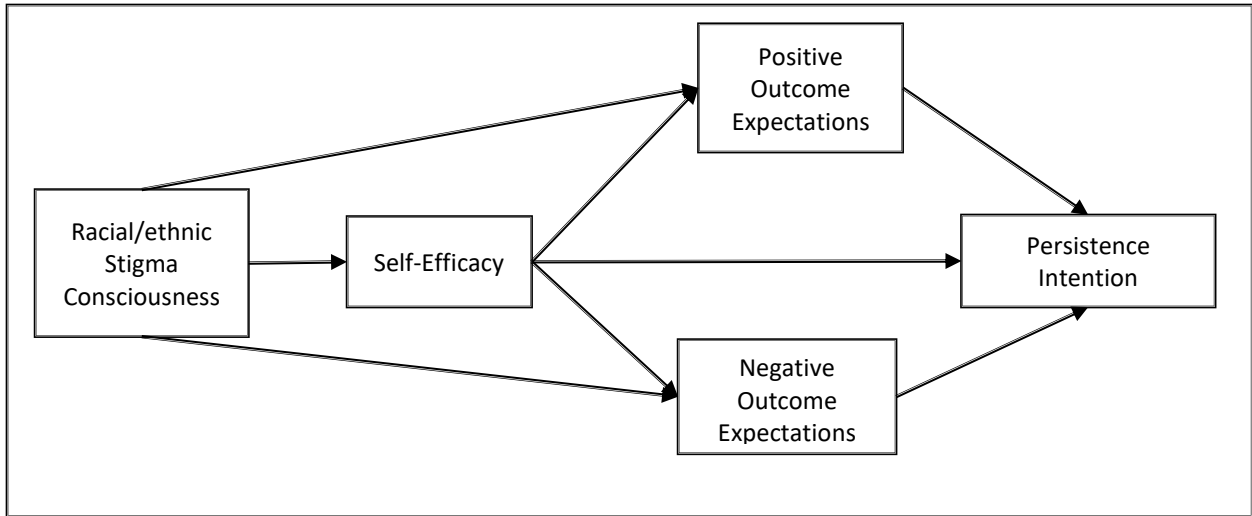
Figure 1. **Hypothesized complete mediation model (Model A)**
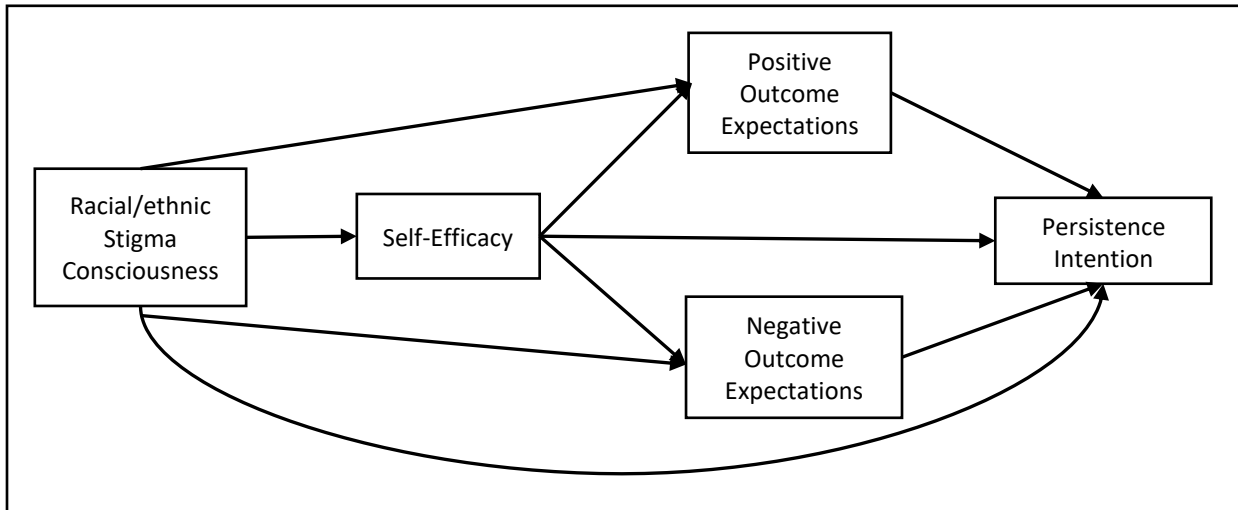
Figure 2. **Hypothesized partial mediation model (Model B).**

The conditional indirect effect of a moderating variable (i.e., coping efficacy) on the

relationship between a predictor (i.e., racial/ethnic stigma consciousness) and an outcome

variable (i.e., engineering persistence intention) via potential mediators (i.e., self-efficacy,

positive outcome expectations, and negative outcome expectations in engineering) were tested.

To test the significance of the indirect (i.e., mediated) effects moderated by coping efficacy, the

Lavaan (Rosseel, 2012) package with bias-corrected 95% confidence intervals (n = 1000) in R

was used. This allowed the explicit test of the moderating effect on the predictor to mediator

paths. The differences of the indirect effects across levels of coping with barrier were tested, and

significant effects are supported by the absence of zero within the confidence intervals. Prior to

all analyses, all measures were mean centered (Aiken & West, 1991).

Preliminary Analyses

The means, standard deviations, and intercorrelations among study variables are

presented in Table 1. Racial/ethnic stigma consciousness had a significant positive correlation

with negative outcome expectations in engineering, but negative correlations with engineering

self-efficacy, positive outcome expectations in engineering, and engineering persistence

intention. Racial/ethnic stigma consciousness had no significant correlation with coping efficacy.

Table 1. **Means, Standard Deviations, and Correlations among Study Variables**

Variable	1	2	3	4	5	6	M	SD
1. R_SC	-	- .09*	- .04*	.27**	- .04*	- .04	3.50	1.26
2. ESE		-	.29**	- .26**	.42**	.18**	7.79	1.67
3. P_EOE			-	- .23**	.34**	.20**	8.23	1.26
4. N_EOE				-	- .13*	- .23**	4.71	1.59
5. EPI					-	.22**	4.75	.56
6. CE						-	3.67	.86

Note. R_SC = Racial/ethnic Stigma Consciousness; ESE = Engineering Self-Efficacy; P_EOE =
Positive Engineering Outcome Expectations; N_EOE = Negative Engineering Outcome
Expectations; EPI = Engineering Persistence Intention; CE = Coping Efficacy.
*$p < .05$, **$p < .01$

Primary Analyses

A suggested model for mediation was tested in the absence of moderation. The results are shown graphically in Figure 1. Most paths in the model were statistically significant, except paths between racial/ethnic stigma consciousness and engineering persistence intentions and between negative outcome expectations in engineering and engineering persistence intentions. The direction for the significant paths was consistent with the hypotheses. To see if the mediation of socio-cognitive variables (i.e., self-efficacy, positive and negative outcome expectations in engineering) between racial/ethnic stigma consciousness and engineering persistence intentions were statistically significant, a Sobel's test was performed. The mediation effect between racial/ethnic stigma consciousness to engineering persistence intentions was significant only via engineering self-efficacy (Sobel's test = -1.96, $p < .05$). There was no evidence that racial/ethnic stigma consciousness indirectly influenced engineering persistence intentions through either positive or negative outcome expectations in engineering.

Figure 3. **Path Model of Socio-Cognitive Variables as the Mediator of the Relation between Racial/Ethnic Stigma Consciousness and Engineering Persistence Intention.**
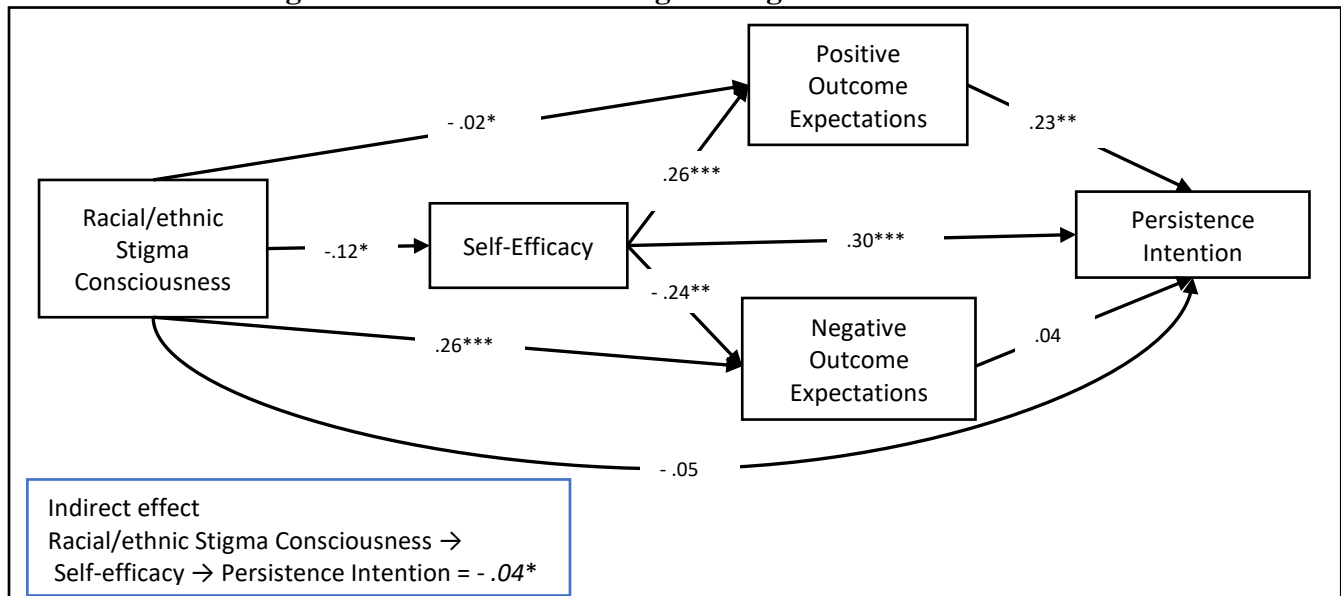
Note. All values reflect standardized coefficients. * $p < .05$, ** $p < .01$, *** $p < .01$

Table 2. **Goodness-of-Fit Indicators for the Nested Path Models**

Model	χ^2/df	CFI	TLI	IFI	SRMR	RMSEA	90% CI for RMSEA
A	1.56	.981	.922	.982	.029	.046	(0.00, 0.105)
B	1.90	.975	.875	.978	.029	.058	(0.00, 0.121)

Note. CFI = Comparative Fit Index; TLI = Tucker-Lewis index; IFI = Incremental Fit Index; SRMR = Standardized Root Mean Square Residual; RMSEA = Root-Mean-Squared Error Approximation

A path analysis including the moderator was also conducted to examine the fit of the hypothesized model to the data, which tested a model whereby coping efficacy moderates the effect of path between racial/ethnic stigma consciousness and the socio-cognitive variables (i.e., self-efficacy, positive and negative outcome expectations in engineering). As shown in Table 2, both Model A and Model B demonstrated excellent fit [χ^2/ df ≤ 3, CFI and TLI values ≥ .90, and RMSEA ≤ .06]. However, compared to Model B, Model A (as in Figure 2) showed better fit in terms of TLI and RMSEA. Though the χ^2 difference was not significant, χ^2 is sensitive to sample size and thus is not considered as the best index to discriminate between good to poor fitting models (Kenny & McCoach, 2003). Even though no significant differences were shown between two models, Model A indicated lower AIC value (i.e., Model A = 5072.874; Model B = 5074.677), supporting Model A's better fit to the data relative to Model B. Hence, Model A was used to test the moderating effects of coping with barriers in the relationships between racial/ethnic stigma consciousness and the socio-cognitive variables.

As shown in Table 3, coping with barriers moderated the path from racial/ethnic stigma consciousness to engineering self-efficacy (B = - .05, B_{se} = .09, t = .52, p < .05), as reflected in a significant interaction between racial/ethnic stigma consciousness and coping efficacy. However, coping with barriers did not moderate the paths from racial/ethnic stigma

Table 3. **Moderated Mediation Analysis for Racial/Ethnic Stigma Consciousness, Coping Efficacy, Engineering Self-Efficacy, and Engineering Persistence Intention**

Variable	B	SE B	t
Mediator – Engineering self-efficacy			
Predictor: Racial/ethnic stigma consciousness	- .13	.08	.09[*]
Moderator: Coping Efficacy	.37	.12	2.96[**]
Interaction: Racial/ethnic stigma consciousness X Coping with barriers	.05	.09	.52[*]
Outcome – Engineering persistence intention			
Mediator: Engineering self-efficacy	.04	.01	5.30[***]
Predictor: Racial/ethnic stigma consciousness	- .01	.01	- .91
	Boot indirect effect/index	Boot SE	95% CI
-1 SD	.013	.006	.013, .060
Mean	.011	.006	.011, .048
+1 SD	.010	.007	.010, .035

consciousness to positive or negative outcome expectations, as reflected in nonsignificant interactions between racial/ethnic stigma consciousness and positive and negative outcome expectations. As zero is not within the CI, this indicates a significant moderating effect of coping efficacy on racial/ethnic stigma consciousness on the indirect effect via self-efficacy (Hayes, 2015). The conditional indirect effect was strongest in those high in coping efficacy via engineering self-efficacy (1 SD above the mean of coping with barriers: effect = .016, SE = .01, 95% CI = .013, 060) and weakest in those low in coping efficacy (1 SD below the mean of coping with barriers: effect = .010, SE = .01, 95% CI = .010, .035). Figure 3 illustrates the moderating effect, such that the combination of higher racial/ethnic stigma consciousness and lower level of coping efficacy was associated with accelerated lower levels of engineering self-efficacy. The model explained 4% of the variance in engineering self-efficacy, 11% in positive outcome expectations in engineering, 16% in negative outcome expectations in engineering, and 21% in persistence intention in engineering.

Figure 4. **Interaction Effect of Coping Efficacy between Racial/ethnic Stigma Consciousness and Engineering Self-Efficacy**
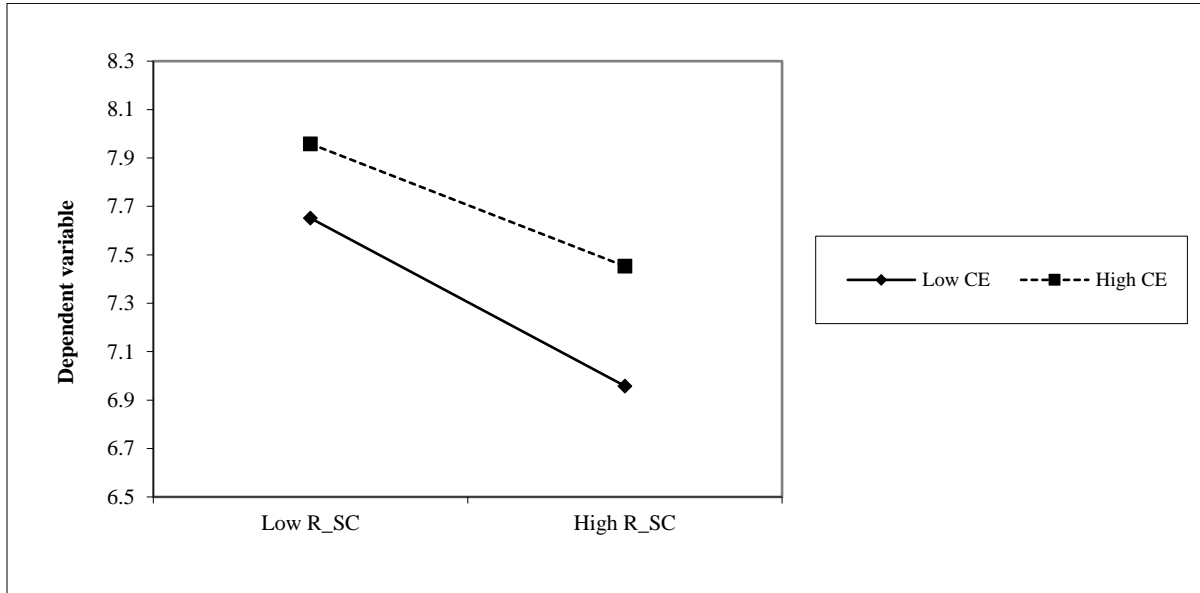
Note. R_SC = Racial/ethnic Stigma Consciousness; CE = Coping Efficacy.

A series of analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA) were conducted to determine whether demographic and contextual variables could explain racial/ethnic stigma consciousness, coping efficacy, and socio-cognitive variables (i.e., self-efficacy, positive and negative outcome expectations, persistence intentions) to pursue an engineering degree. The demographic variables examined in this study were engineering students' age, gender, race/ethnicity, sexual orientation, institution type, and generational status. Given D'amico, Neilands, and Zambarano's (2001) suggestion for the sample size of group comparisons in MANOVA, groups comprised of less than 50 members were merged or excluded in this analysis. Therefore, transgender ($n = 2$) and Native American ($n = 4$) were excluded. Additionally, generational status and sexual orientation were merged into one group if less than 50 members were identified of each group. As a result, third, fourth, and fifth generational status were merged into one group into a group labeled "3rd generation and above", and gay, lesbian,

bisexual, and other sexual orientation were merged into a group labeled "Lesbian, Gay, and Bisexual+ (LGB+) group." To capture the age group differences, age was grouped into three different groups: below 20 ($n = 51$), between 21 and 25 ($n = 114$), and above 26 ($n = 100$).

With regard to the racial/ethnic stigma consciousness, results did not show significant effects for age, F (2, 264) = 1.492, $p = .23$, or sexual orientation, t (263) = .317, $p = .75$. However, an independent sample t-test indicated that the level of racial/ethnic stigma consciousness were significantly higher for students who attending PWIs ($M = 3.68$, $SD = 1.29$) than for students who attending MSIs ($M = 3.31$, $SD = 1.21$), F (1, 264) = 5.237, $p = .023$, ω^2 = .02. as well as gender, suggesting significantly higher levels of racial/ethnic stigma consciousness for woman ($M = 3.79$, $SD = 1.17$) than for man ($M = 3.28$, $SD = 1.33$), F (2, 262) = 10.738, $p = .001$, $\omega^2 = .03$. There were also significant effects for race/ethnicity, F (2, 258) = 10.012, $p < .001$, $\omega^2 = .06$, and generational status, F (2, 264) = 4.689, $p = .010$, $\omega^2 = .03$. Based on the results of one-way analysis of variance, the mean differences are shown in Table 4. Results indicated that at least one comparison with overall participants was not zero. To understand each group's differences, post hoc multiple comparison with Scheffe's method was adopted in case multiple groups were identified (see Table 5). Mean differences of racial/stigma consciousness between engineering students who identified as Black/African American and Latinx/Hispanic American as well as Multiracial/ethnic were .76 ($p < .001$) and .55 ($p = .046$) respectively. Regarding generational status, a significant mean difference was only detected between 1st generation and above 3rd generation groups, showing a mean difference -.66 (p = .011).

Table 4. *One-way ANOVA of Racial/Ethnic Stigma Consciousness and Coping Efficacy between Groups*

			Sum of Squares	df	Mean Square	F
R_SC	Institution Type	Between groups	8.33	1	8.33	5.237[*]
		Within groups	418.24	263	1.59	
		Total	426.57	264		
	Race /Ethnicity	Between groups	30.44	2	15.22	10.012[***]
		Within groups	392.21	258	1.52	
		Total	422.64	260		
	Gender	Between groups	16.78	1	16.78	10.738[***]
		Within groups	47.93	261	1.56	
		Total	426.57	263		
	Generation	Between groups	14.74	2	7.37	4.689[**]
		Within groups	411.83	262	1.57	
		Total	426.57	264		
	Age	Between groups	4.80	2	2.40	1.492
		Within groups	421.77	262	1.61	
		Total	426.57	264		
	Sexual Orientation	Between groups	.16	1	.16	.101
		Within groups	426.41	263	1.62	
		Total	426.57	264		
CwB	Institution Type	Between groups	.66	1	.66	.878
		Within groups	197.52	263	.75	
		Total	198.18	264		
	Race /Ethnicity	Between groups	.98	2	.49	.650
		Within groups	194.47	258	.75	
		Total	195.45	260		
	Gender	Between groups	1.00	1	1.00	1.336
		Within groups	195.30	261	.75	
		Total	196.30	262		
	Generation	Between groups	.16	2	.08	.103
		Within groups	198.02	262	.76	
		Total	198.18	264		
	Age	Between groups	.31	2	.15	.815
		Within groups	197.87	262	.76	
		Total	198.18	264		
	Sexual Orientation	Between groups	.17	1	.17	.634
		Within groups	198.01	263	.75	
		Total	198.18	264		

NOTE. R_SC = Racial/Ethnic Stigma Consciousness, CwB = Coping with Barriers. $* p < .05$, $** p < .01$, $*** p < .001$

The effect of demographic components was also examined for coping with barriers. There were no significant mean differences based on institution type, $F(1, 263) = .88$, $p = .35$, gender, $F(1, 262) = 1.34$, $p = .25$, sexual orientation, $F(1, 264) = .23$, $p = .63$, race/ethnicity, $F(2, 260) = .65$, $p = .52$, generational status, $F(2, 264) = .10$, $p = .90$, or age, $F(2, 264) = .20$, $p = .82$.

A multivariate analysis of variance (MANOVA) was used to compare the effect of demographic/contextual variables on the socio-cognitive variables, engineering self-efficacy, engineering positive/negative expectations, and persistence intentions in engineering. The multivariate test of the differences among the two groups, PWIs vs. MSIs, was significant, Wilks' Lambda = .926, $F(1, 263) = 5.216$, $p = .000$, partial $\eta^2 = .074$. Of the univariate tests, engineering self-efficacy, $F(1, 263) = 11.410$, $p = .001$, partial $\eta^2 = .042$, and positive outcome expectations were significant, $F(1, 263) = 4.687$, $p = .031$, partial $\eta^2 = .018$, accounted for approximately 4.2% and 1.8% of the variance in the multivariate outcomes, respectively. The univariate tests engineering negative outcome expectations, $F(1, 263) = 1.005$, $p = .40$, partial $\eta^2 = .002$, and persistence intentions in engineering, $F(1, 263) = .394$, $p = .53$, partial $\eta^2 = .001$ were not significant.

For gender, the multivariate result was significant as well, Wilks' Lambda = .867, $F(1, 262) = 8.907$, $p < .001$, $\eta^2 = .121$. Of the univariate tests, engineering self-efficacy, $F(1, 262) = 7.066$, $p = .008$, partial $\eta^2 = .026$, and negative outcome expectations, $F(1, 262) = 28.582$, $p < .001$, $\eta^2 = .099$ were significant, accounting for approximately 2.6% and 9.9% of the variance in the multivariate outcomes, respectively. However, engineering positive outcome expectations, $F(1, 262) = .264$ $p = .61$, partial $\eta^2 = .001$, and persistence intentions in engineering, $F(1, 262) = .299$, $p = .59$, partial $\eta^2 = .001$, were not significant. The multivariate test of the differences

among age groups was significant, Wilks' Lambda = .929, F (2, 264) = 2.414, p = .015, η^2 = .036. No univariate tests showed significant results: engineering self-efficacy, F (2, 264) = 2.425, p = .09, partial η^2 = .018, positive outcome expectations, F (2, 264) = 2.992, p = .052, partial η^2 = .022, negative outcome expectations, F (2, 264) = 2.579, p = .078, partial η^2 = .019, and persistence intentions in engineering, F (2, 264) = 2.517, p = .083, partial η^2 = .019. Finally, the result of the multivariate test between heterosexual and LGB+ groups showed significant differences, Wilks' Lambda = .962, F (1, 264) = 2.542, p = .040, partial η^2 = .038. Of the univariate tests, engineering self-efficacy was only significant, F (1, 264) = 9.467, p = .002, partial η^2 = .035, accounted for approximately 3.5% of the variance in the multivariate outcomes. The multivariate result for race/ethnicity, Wilks' Lambda = .973, F (2, 260) = .873, p = .54, η partial ^{2} = .014 and generational status, Wilks' Lambda = .950, F (2, 264) = 1.678, p = .101, partial η^2 = .025 were not significant. Only engineering self-efficacy was significant of the univariate tests for generational status, F (2, 264) = 3.526, p = .031, partial η^2 = .026, accounting for approximately 2.6% of the variance in the multivariate outcome.

Table 5. **Significant Multiple Comparison of Racial/Ethnic Stigma Consciousness, Coping Efficacy, and Socio-Cognitive Variables by Each Group**

		Group	Group	Mean Diff	SE	*p*	95% CI Lower bound	Upper bound
R_SC	Race	Black/African American	Latinx/Hispanic American	.76	.17	.000	.34	1.18
		Black/African American	Multiracial/ethnic American	.55	.22	.046	.01	1.09
	Generation	1st Generation	Above 3rd Generation	- .66	.22	.011	-1.20	- .12
ESE	Gender	Men	Women	.53	.20	.008	.14	.92
	Sexual Orientation	Heterosexual	LGB+	.88	.28	.002	.32	1.44
	Generation	1st Generation	2nd Generation	.69	.26	.033	.04	1.33
N_EOE	Gender	Men	Women	- .99	.19	.000	-1.36	- .63

NOTE. R_SC = Racial/Ethnic Stigma Consciousness, ESE = Engineering Self-Efficacy, N_EOE = Negative Engineering Outcome Expectations.

Chapter V

Discussion

The purpose of the proposed study was to understand URM engineering students' career development with a focus on the influence of proximal contextual barriers. Specifically, racial/ethnic stigma consciousness, a schema of anticipation that others will stereotype a person regardless of that person's behavior (Pinel, 1999), was examined for its relationship with career variables with the consideration of context (i.e., PWIs vs. non-PWIs). Additionally, coping efficacy for barriers to education and career was included as a variable that could lead to an understanding of how levels of confidence in responding to educational/career barriers might buffer the effect of negative racial/ethnic stigma consciousness. Thus, this study extends SCCT by incorporating a new construct and also including negative outcome expectations in the model, responding to a call for advancing research on SCCT with implications for potential interventions to help individuals in coping with environmentally imposed barriers (Brown et al., 2018; Lent et al., 2000).

As hypothesized and consistent with prior research (e.g., Deemer et al., 2014; Lent et al., 2018; Sheu et al., 2010), the findings suggest a negative relation between racial/ethnic stigma consciousness and engineering self-efficacy. As URM students who are high in stigma consciousness tend to perceive greater discrimination against themselves and members of their group (Pinel, 1999), participants in the current study may be more vigilant to environmental cues that do not encourage their success in engineering. This finding is consistent with Mosely and Rosenberg (2007) where they warned about an 'interpretative frame' for self-evaluation that stigma consciousness could create for individuals, leading not only hampering individual achievement and emotional involvement in education for marginalized groups. As stigma

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consciousness was a negative predictor of self-efficacy, it may be inferred to carry the deleterious effects of low self-efficacy on persistence and goal behaviors (Brown et al., 2008; Lee et al., 2015; Robbins et al., 2004; Wright, Jenkins-Guarnieri, & Murdock, 2012). This result also confirms Brown et al's (2018) meta-analysis in regard to relationships among supports and barriers and career and educational outcomes where they documented discrimination as a barrier accounted for approximately 9% of the variance in academic persistence, versus 1% or less of the variance for the other career and educational outcomes. This suggests the importance of continued efforts to reduce discrimination and promote equality in the school environment. Indeed, the inclusion of stigma consciousness as a proximal contextual barrier could provide understanding of interactions between person and environment that impede career development in the SCCT framework (Lent et al., 2002, 2003).

The hypothesized relationships of coping efficacy with self-efficacy and stigma consciousness were partly supported. As Lent et al. (2000) suggested, a potential complementary role of coping efficacy relative to task self-efficacy, a positive relation between coping efficacy and self-efficacy was supported. This result is also consistent with prior research that has found a modest association between self-efficacy and coping efficacy (Byars-Winston & Fouad, 2008; Lent et al., 2001; Thompson, 2008). However, coping efficacy was not significantly associated with stigma consciousness, suggesting that the participants' perception of their ability to overcome obstacles may not be necessarily related to expectation of judgment based on their race/ethnicity. This may indicate weak associations between perceived barriers and coping efficacy for their racial/ethnic identity among URM students, as an individual who often stigmatized by others. This is somewhat different finding compared to Flores et al.'s (2020) where they documented significant relations among perceived barriers and coping efficacy in

engineering across three years from their study targeted Latinx engineering students in Hispanic

Serving Institutions, calling for further investigation to differentiate coping efficacy for different

barriers, such as content (e.g., engineering) or contextual/personal input (e.g., discrimination

based on identity).

As a whole, the hypothesized research model (hypothesis 1) was supported with the

excellent fit to data. Therefore, relations between variables in this study, as proposed by SCCT,

were supported. Specifically, an indirect effects model that included only complete mediation

effects of racial/ethnic stigma consciousness on persistence intention through self-efficacy,

indicated a better fit than a partial mediation model that included a direct path between

racial/ethnic stigma consciousness and persistence intention in engineering. This finding

supports Lent et al.'s (1994, 2000, 2003) assertion on proximal influences that lead to associated

interests, goals, and actions by assisting in determining whether self-efficacy and outcome

expectations for a certain career path instead of a direct influence on goals by proximal

influences. Indeed, Lent and Brown's (2019) most recent meta-analysis of SCCT summarized

their findings about the role of barriers that tend to yield small paths to goals indirectly via self-

efficacy and outcome expectations. For STEM fields, Found and Santana (2017) suggested the

potential effect of systemic barriers (e.g., racism) that hinder the entrance and persistence in a

career field via their influences on self-efficacy and outcome expectations among

underrepresented groups. In fact, researchers (e.g., Mattison & Aber, 2007) have documented

perceived and actual experiences of racism hinder their immediate educational opportunities and

later career outlooks among African American college students, and the current study further

explained the internal mechanism of how the level of perceived stigmatization for one's

racial/ethnic groups may influence the level of persistence intention through self-efficacy belief

among URM students in engineering. Deemer et al. (2014) also documented the role of self-efficacy, in the laboratory classroom setting, that could serve as a critically important protective mechanism by buffering the effects of stereotypic cues in the face of threatening stereotypes among women chemistry and physics major. That is, high stigma consciousness does not necessarily translate into a decreased likelihood of pursuing engineering degrees. Rather, it seems that confidence in engineering is needed to carry this effect indirectly from racial/ethnic stigma consciousness to persistence intention URM students where they assume they will be poorly received or valued.

Given scholars' concerns in measurement issue for outcome expectations as a central SCCT construct, not only positive but also negative outcome expectations in engineering were included in the research model with the expectation that both positive negative outcome expectations may mediate the relations between stigma consciousness and persistence intention. While both outcome expectations showed significant and expected associations between variables in the current study, there was no significant indirect effects for both positive and negative outcome expectations was shown. For oppressed groups, the role of outcome expectations in the development of career goals has been highlighted, such as the payoffs associated with STEM fields (Brown, 1995; Morris, 1996). However, the current finding may add another evidence about the complicated function of outcome expectations with proximal contextual factors for underrepresented populations in engineering. Indeed, the inclusion of stigma consciousness as a proximal contextual barrier provides understanding of person and environment interactions that inhibit career development in the SCCT framework (Lent et al., 2003; Lent et al., 2002).

Importantly, the moderation effect of coping efficacy was significant in the relationship between racial/ethnic stigma consciousness and engineering self-efficacy. Although only few researchers have investigated coping as a moderator of barriers within SCCT (Cadaret et al., 2016; Novakovic & Gnilka, 2015; Thompson, 2008), this finding suggests an important area of consideration. Consistent to Cadaret et al.'s (2016) findings, the results of this research indicate that coping efficacy can be one tools used by students to lessen the potential impairment that are caused by discouraging environments. Furthermore, the moderated mediation effects between stigma consciousness and persistence intention through engineering self-efficacy were observed to decrease as the levels of coping efficacy increased. In other words, URM engineering students' racial/ethnic stigma consciousness would further aggravate persistence intention via self-efficacy beliefs depending on the level of individuals' coping efficacy. Even within the similar environments, contextual factors act dissimilarly on every individual. Some individuals can buffer their internalized messages by utilizing appropriate coping skills whereas others cannot. Given the engineering programs' a notorious national reputation of being competitive and rigorous (Cross & Jensen, 2018), this result highlights the roles of career counselors and engineering educators to promote a global confidence in one's ability to overcome educational and career barriers that may protect against the afflicted effects of chronic and internalized discrimination consciousness due to their identity as an underrepresented student in the fields.

Relatedly, Flores et al. (2020) discussed the role of perceived barriers as a protective factor to learn important skills to cope with challenges for Latinx engineering students. These researchers noted less of a decline of coping efficacy despite of the growth of perceived barriers in engineering across 3 years. It is noteworthy, however, that Flores et al (2020) measured perceived barriers in content level (i.e., engineering) rather in internalized or chronic belief.

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Thus, it might be important to differentiate the perceived barriers for better understand the role of coping efficacy and its relationship with different types of perceived barriers in the future study.

As hypothesized, it is also notable that participants in this study reported different levels of racial/ethnic stigma consciousness depending on their institution type (i.e., PWIs vs. MSIs). Specifically, in the context of PWIs where they may face barriers, including implicit bias (Moody, 2004; Turner, González, & Wood, 2008) and established environmental culture(s) and traditions that reflect White culture (Harper, 2012; Zambrana et al., 2015) in engineering, URM students reported significantly higher level of racial/ethnic stigma consciousness than their counterparts who attend MSIs. Within the environment of PWI, Pinel and her colleagues (2005) reported a significant difference regarding students' changed level of stigma consciousness depending on their race/ethnicity. From their investigation, Black and Latinx students reported a significant increase in their stigma consciousness levels upon arriving at PWI compared to White and Asian students. Taken together, this finding is consistent with a host of laboratory investigations of stigma consciousness that showed an increased tendency to attribute ambiguous negative feedback from men to sexism along with situational manipulation (e.g., reflect upon times when their group is stereotyped) by Pinel (2004). However, this result adds to the literature by demonstrating the relevance of stereotype threat experiences outside of the artificial environment of the psychology lab. Indeed, even though stigma consciousness was initially introduced and tested as an interpretive tendency with stable differences across individuals (Pinel, 1999), this finding further emphasizes the role of context on URM students' level of stigma consciousness that may influence on academic experiences, well-being, and even career pursuing process.

To summarize, this study extends the literature in several ways. First, this study tested SCCT choice model with a consideration of intersectionality by including both race/ethnicity and institution types. Particularly, the role of contextual factors has been discussed widely among researchers, calling for further investigations (e.g., Lent & Brown, 2019). Second, this study broadened further understanding the interactions between personal and environmental factors by adding a construct of stigma consciousness in the SCCT model, and results demonstrated that it explains URM engineering students' persistence intention, mainly through self-efficacy belief in engineering. Coping efficacy as a moderator in the relation between stigma consciousness and self-efficacy was also included, which suggests that increasing coping efficacy for buffering internalized harmful belief that may be increased with the environment. Third, the study included both positive and negative outcome expectations in engineering and showed the significant effect of negative outcome expectations for URM engineering students in pursuing their degrees, providing further understanding about one of core constructs in SCCT framework.

Other findings

In this study, other demographic information of participants was also investigated as potential factors associated with different levels of stigma consciousness, coping efficacy, and socio-cognitive variables. In addition to institution type, participants' race/ethnicity, gender, and generational status showed significant different level of stigma consciousness. Specifically, Black/African American engineering students reported significantly higher levels of stigma consciousness than Hispanic/Latinx American students as well as multiracial/ethnic students, suggesting potential varied levels of internalized belief between those two groups. One potential factor explaining this difference between the two groups could be attributed to differences in exposure to racial socialization messages. According to Chávez and French (2007), these

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messages are most often transmitted from parent to child and often shape an individual's racial

identity development. Prior researchers (e.g., Hughes, 2003) showed Black parents tend to

transmit more racial socialization messages with the purpose of preparing for bias compared to

Latinx parents. That is, Black/African American participants in the current study may have

developed a stronger internalized stigmatization about their racial/ethnic identity, calling for

additional attention to exploring each group's career development and to understanding factors

that lead to variations within a single URM group. Indeed, racial-cultural variations in the way

people view and understand their identity should be further emphasized (Sue & Sue, 2003; Lee et

al., 2017; Nilsson et al., 2003; Flores et al., 2006). Similarly, different levels of stigma

consciousness across gender and generational status among URM engineering students suggests

the needs for intersectional approaches to examine the multiple systems of oppression that

deeply intertwined to influence experiences and opportunities among individuals and groups

(Bowleg, 2012; Cho, Crenshaw, & McCall, 2013; Collins, 2015; Museus & Griffin, 2011;

Warner & Shields, 2013).

Practical Implications

Increasing the retention of URM students in STEM education can be considered as a

social justice issue (Treisman, 1992). Many faculty and administrators have voiced their moral

obligation to provide opportunities to them, leading the goal of increasing the educational

attainment of URM students as an institutional priority (Gasman, 2011). Traditionally, STEM

education often emphasizes "survival of the fittest," attributing failure in STEM to student

characteristics and leaving the institutional or cultural practices of college and universities

largely free from blame and responsibility (Armstrong & Thompson, 2003; Gasman, 2011). The

current study's findings further stir discussions on the institutional role in empowering students

by including the context (i.e., PWIs vs. MSIs) in consideration of their level of persistence in engineering. Particularly, given its interactive roles of context on URM students' level of stigma consciousness, a few strategies for promoting attainment in engineering for URM students are suggested. First, institutions need to create and/or strengthen their inclusive curriculum with the process of decolonization in the fields. One of main reasons that URM students find their STEM classes to be disaffecting is the perception that the curricular are gender biased and Eurocentric (Carter et al., 2019). Researchers have found that textbook rarely identify authors by race/ethnicity and only few faculty members mention race/ethnicity during their class discussions (Núñez et al., 2020), resulting in seldom discussion regarding the historical influence of non-Western civilization in the fields. In fact, the use of a curriculum that draws on the multifaceted history of the STEM fields has been considered as a significant factor of the success for many historically black colleges and universities (Gasman & Perna, 2011). Second, educators may reconsider the use of pedagogical approaches that engage URM students in learning that require further action and collaboration than passive reception of knowledge. Seymour and Hewitt (1997) emphasized the importance to collaborative learning and active engagement in the STEM classroom for students of color and women, as they tend to "sought-after, used, [and] appreciated" group learning more than other students (p. 174). Considering that most companies, especially those in science and technology fields, look for individuals who can work in teams collaboratively, even integrating the socio-ethical factors (Long & Blok, 2018), engineering educators may seriously take on the role of "confidence builder" by actively facilitating positive student interactions with peers and faculty, creating and supporting effective study groups, and developing and promoting an atmosphere that encourages students to work together to help one another rather than compete with one another (Triesman, 1992). Third, faculty and staff may

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examine their relationships with URM students as a source of support. Researchers consistently noted the crucial role of student-faculty relationships for URM students (e.g., Winkle-Wagner, 2010), as these student-faculty relationships can help reframe negative institutional messages around race/ethnicity and gender, particularly in PWIs. Given a long history of White paternalism (i.e., White people know what is best for People of Color), faculty and staff must not only reflect on their "colorblind" tendency but also develop an understanding and appreciation for different identities, recognizing their critical influence on each URM student in STEM (McCoy, Winkle-Wagner, Luedke, 2015).

Notably, the moderating effect of coping efficacy from the current study also suggests important implication on how mental health practitioners and educators can help URM students persist their engineering degrees, as the current study's result indicated the critical roles of coping efficacy that can mitigate its negative outcomes in their academics and career by promoting self-efficacy belief. Indeed, engaging in coping strategies has been documented as a tool to enable URM students to achieve academic success in spite of negative race-related experiences on campus and high levels of stress (e.g., Greer & Chwalisz, 2007). Pieterse et al. (2010) documented the impact of racism-related stress that accounted for an additional 4% - 8% of the variance in outcomes such as well-being and psychological distress after controlling for levels of general stress experienced by individuals, which supports the need to promote URM students' coping strategies.

Although previous research (e.g., Harper, 2013) have shown the primary behavioral strategy to cope with race-related stressors was working hard to disprove negative stereotypes and persisting in the face of discrimination, scholars have cautioned potential negative psychosocial impact that may be associated with this coping strategy (McGee & Stovall, 2015).

Smith and colleagues (2007) noted the potential cognitive, emotional, and physical exhaustion that could be caused by sustained and high-effort coping with negative race-related stressor over time (i.e., *racial battle fatigue*), proposing the needs for diversified coping strategies. That is, it might be necessary to validate the URM students' experiences, while also offering opportunities to review the circumstances and identify factors that elicited perceptions of threat. Counselors need to provide not only support to decrease defensiveness but also supports to address and ameliorate the painful nature of race-related stressors to develop appropriate strategies to manage the specific threat. A use of "possible selves" was also suggested by Oyserman et al. (2007). This approach encourages individuals to incorporate aspects of different types of group identities. By implementing this approach, URM students may be able to shift the focus of one's attention, even when experiencing strong emotions, which could lessen their levels of stigma consciousness and, in turn, strengthen the levels of self-efficacy.

Furthermore, the ways to assist URM students to cultivate racial socialization by installing cultural resources and coping strategies to strengthen their cultural identity development should be discussed. Social groundedness (e.g., having strong social support in multiple cultural groups) and knowledge of one's own culture have been regarded as two components to buffer the impact of racism-related distress on depression (Wei et al., 2010). Thus, counselors and engineering educators could develop interventions to build social groundedness and cultural awareness. Outreach activities, diversity dialogue, or multicultural workshop could be ways that can help majority students, faculty, and staffs appreciate URM students' racial/ethnic backgrounds in engineering.

Limitation and Future Directions

The current study has several limitations worth noting that can inform the development of future studies. First, this study involved a sample of URM engineering students who were mostly Hispanic/Latinx American and Black/African American, limiting generalizability across URM students in engineering. As discussed in other findings, generalizing among URM populations may promote stereotypical beliefs and hamper accurate understanding of each group. Importantly, unbalanced and limited number of URM participants for each institution type limited further understanding how intersectional identities may influence on engineering students' career relevant constructs. For example, even within PWIs, each URM group may have different experiences that are likely to affect their level of stigma consciousness. Similarly, for the MSI settings, students may hold different level of stigma consciousness around their own racial/ethnic identity depending on institution type (e.g., Hispanic Serving Institutions vs. Historically Black Colleges and Universities). In fact, scholars have documented concerns revolving around intergroup racism and diverse understandings of the challenges each group faces (e.g., Foley, 2010), suggesting different group positionality intertwined their context. Thus, future studies should consider examining the interactions with race/ethnicity and institution type by gathering larger samples.

Second, this study examined the URM students' perception in their stigmatized identity in their context rather than actual components of the environment, such as the presence of mentors or role models. Previous research has demonstrated the significant impact of role models, particularly in stereotyped domains (e.g., Griffith et al., 2019). Given the role of learning experiences on self-efficacy in SCCT, examining such environmental factors for URM students in future research is particularly important. Furthermore, future research might include the different layers of the context that were not included in this study. In addition to contextual

factors, given that individual may experience different levels of stigma consciousness depending

on who they interact with as well as when they encounter, even within the same context, it might

be important to explore differentiating factors that may buffer adverse impact on race-related

stressors. Third, a cross-sectional design was used for the current study, which did not allow for

exploring temporal predominance or causality among the variables. Future studies could consider

longitudinal tests of the choice model with a consideration of contextual factors that the present

study incorporated (i.e., institution type, stigma consciousness, coping efficacy). Similarly,

qualitative methods may further help understand URM engineering students' lived experiences,

which is likely to differentiate different layers of dynamic amongst socio-cognitive and

contextual factors.

Lastly, experimental designs may assist to understand the influence of various

interventions on coping with stigma and discrimination regarding identities in engineering.

Brondolo et al. (2009) posited their conclusion about a significant need for further research on

strategies coping strategies with race-related stressors from their selective revies of the literature

about coping with racism. For example, previous research has produced mixed findings for the

role of cognitive-emotional debriefing, with some researchers found it associated with both

negative consequences (Thomas et al., 2008) and positive outcomes (Gaylord-Harden et al.,

2008). Thus, future research can apply experimental design to examine variations in the

effectiveness of coping strategies to deal with subtle race-related stressors, involving multiple

outcome measures to account differential effects on functioning, affect, and health. Further,

given that the research model may be subject to Single Source Bias (SSB; Campbell & Fiske,

1959), inclusion of third variable, such as measuring physiological responses to reflect upon

times when their group gets stereotyped, will help not only develop tailored intervention but also address the overlapping variability due to the data being driven by single source.

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APPENDICES

Appendix A.

Recruitment Email

Dear Engineering Student,

My name is Bo Hyun Lee, M.A., and I am a doctoral student in counseling psychology at the University of Missouri, Columbia. I am conducting my dissertation under the supervision of Dr. Lisa Y. Flores to examine psychosocial and contextual factors among historically underrepresented students in their process of pursuing an engineering degree. I am writing to ask for your participation in this study. Your participation can provide valuable input on better understanding the role of psychosocial factors in pursuing engineering degree. Participation involves completing a confidential online survey (approximately 20-25 minutes to complete) at your convenience. Participation in this study is completely voluntary, and this research has been approved by the Institutional Review Board for Human Subjects in Research at University of Missouri (MU IRB # 2017708).

To participate in this study, you need to be **18 years of age or older who identify as African American/Black, Hispanic American/Latinx, Native American, and Bi/Multi Racial American.** You also need to be declared major within engineering fields as of Fall Semester 2020. Individuals who consider majoring Engineering, but did not declare engineering as a major are not eligible for this study.

If you are interested in participating in this study, please click on the link below, fill out the informed consent form, and complete the study.

https://missouri.qualtrics.com/jfe/form/SV_6fAyiv9x6zPAjNr

In exchange for participating in the study, if interested, you may enter a drawing for a chance to win one of 50 Amazon gift cards of $10, one of 15 Amazon gift cards of $20, one of three Amazon gift cards of $50, one of two Amazon gift cards of $75, and one $100 Amazon gift card. Please note that your email address will not be used to identify you in any way and submitting your email address is totally voluntary.

If you have any questions about the study, please contact the principal investigators at the email or phone below. Thank you for your interest in this study. Your participation is greatly appreciated.

Sincerely,

Bo Hyun Lee, M.A.
Doctoral Student in Counseling Psychology
University of Missouri—Columbia

Appendix B

<u>Informed Consent Form</u>

(First Page of Survey)

Informed Consent

Please read this consent form carefully before you decide to participate in this study.

Purpose of the research study: The purpose of this study is to learn more about the contextual and socio-cognitive factors that influence the academic and career development among the historically underrepresented college students pursuing a degree in engineering. This information will assist in better understanding the process in which students decide to pursue an engineering degree as well as the variables that impact persistence in both engineering education and careers. You will be asked to respond to a survey that will take approximately 20-25 minutes to complete. There are no right or wrong answers—just fill in the responses that first come to your mind. In order for the results to truly represent your current situation, it is important to fully complete the survey. However, you may choose not to answer any questions with which you are uncomfortable. Please keep your answers private.

Eligibility to Participate: We are limiting this study to self-identified African American, Latinx American, and Native American (age 18 and over) who are engineering majors as of Fall semester 2019.

Confidentiality: Participation is voluntary, and all of your responses will be anonymous. None of the responses will be connected to identifying information.

Benefits: Participation in this study may increase your awareness regarding your academic and career decision-making processes. In addition, you will be providing valuable information that will help us to better understand the factors that impact the goals and persistence of engineering students. Your participation will add to the knowledge base of psychologists and educators.

Compensation: If you choose to participate in the current survey, you may enter a drawing for a chance to win one of 50 Amazon gift cards of $10, one of 15 Amazon gift cards of $20, one of three Amazon gift cards of $50, one of two Amazon gift cards of $75, and one $100 Amazon gift card.

Risks: The only associated risk in participating in this study is the discomfort you may feel in thinking about sensitive and important personal decisions. However, there is no more than minimal risk.

Therefore, you should protect yourself from these types of occurrences identified below:
1. There is a possibility that your responses can be viewed by an outside party if you do not EXIT/CLOSE your Internet browser (e.g., Netscape Navigator, Internet Explorer, etc.) as soon as you finish responding to the questionnaire because your responses might be

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visible if you (or someone else) click the BACK button on the browser. In order to ELIMINATE this possibility, you should EXIT/CLOSE the browser as soon as you finish responding to the survey and have submitted your responses.

2. There is a possibility that your responses can be viewed by an outside party if you leave your browser on and leave the computer terminal before finishing the questionnaire (e.g., answer the phone, leave the computer unattended, etc.). In order to avoid inadvertent access to your responses by a third party, do not leave the terminal or stop responding to the questionnaire until you have completely finished and closed the browser.

Whom to contact if you have questions about the study: Bo Hyun Lee, Department of Educational, School & Counseling Psychology, University of Missouri, Email: bldn8@mail.missouri.edu

Whom to contact about your rights as a research participant in the study: Please contact the University of Missouri – Columbia Institutional Review Board (IRB) at irb@missouri.edu or 573-882-3181.

Agreement: I have read the procedure described above. I voluntarily agree to participate in the procedure and I have received a copy of this description.
- o Agree
- o Disagree

Appendix C

<u>Demographic Information</u>

Directions: *The following are some questions about you and your family. Please* ***<u>fill in, check, OR circle</u>*** *the best description of you and your family members.*

Your Age: (insert number)

Your Sex:
  a. Female
  b. Male
  c. Trans Male/Trans Man
  d. Trans Female/Trans Woman
  e. Genderqueer/Gender Non-Conforming
  f. Others (please specify): _____

Your sexual orientation:
  a. Heterosexual (Straight)
  b. Gay
  c. Lesbian
  d. Bisexual
  e. Not listed above (please specify): _____

Your ethnicity:
  a. Asian or Asian American
  b. Black or African American
  c. Hispanic or Latinx
  d. White, Caucasian, European, not Hispanic
  e. American Indian
  f. Multiracial/Multiethnic: parents are from two different groups
  g. Other (please specify): _____

Circle the generation that best applies to you.
  a. 1st generation (you were born in Mexico or other country)
  b. 2nd generation (you were born in USA; either parent born in Mexico or other country)
  c. 3rd generation (you were born in the USA; both parents born in USA and all grandparents born in Mexico or other country)
  d. 4th generation (your and your parents born in USA and at least one grandparent born in Mexico or other country with remainder born in the USA).
  e. 5th generation (you and your parents born in the USA and all grandparents born in the USA)

Class Standing:
  a. Freshman
  b. Sophomore

c. Junior
d. Senior
e. Other (please specify): _____

Please identify your major:
  a. Chemical Engineering
  b. Civil Engineering
  c. Electrical and Computer Engineering
  d. Engineering Physics
  e. Engineering Technology
  f. Industrial Engineering
  g. Information and Communication Technology
  h. Mechanical Engineering
  i. Aerospace Engineering
  j. Surveying Engineering
  k. Other (please specify): _____

Appendix D

Engineering Self-Efficacy

Engineering Self-Efficacy Scale (ESE)
Lent, Brown, et al. (2005)

Instructions: The following is a list of major steps along the way to competing an engineering degree. Please indicate how much confidence you have in your ability to complete each of these steps in relation to the engineering major that you are most likely to pursue. Use the 0-9 scale below to indicate your degree of confidence. How much confidence do you have in your ability to:

	No Confidence at all		Some Confidence						Much Confidence	
1. **Complete all of the "basic science" (i.e. math, physics, chemistry) requirements for your engineering major with grades of B or better.**	0	1	2	3	4	5	6	7	8	9
2. **Excel in your engineering major over the next semester**	0	1	2	3	4	5	6	7	8	9
3. **Excel in your engineering major over the next two semesters. Complete the upper level required courses in your engineering major**	0	1	2	3	4	5	6	7	8	9
4. **Complete the upper level required courses in your engineering major with an overall grade point average of B or better.**	0	1	2	3	4	5	6	7	8	9

Appendix E

Positive Engineering Outcome expectations

The Positive Engineering Outcome Expectations Scale (POE)
Lent, Brown, et al. (2003)

Instructions: Using the scale 0 to 9 below, please indicate the extent to which you agree or disagree with each of the following statements. <u>Graduating with a BS degree in engineering will likely allow me to:</u>

	Strongly Disagree		Disagree		Unsure			Agree		Strongly Agree
1. ......receive a good job offer.	0	1	2	3	4	5	6	7	8	9
2. ......earn an attractive salary.	0	1	2	3	4	5	6	7	8	9
3. ......get respect from other people	0	1	2	3	4	5	6	7	8	9
4. ......do work that I would find satisfying.	0	1	2	3	4	5	6	7	8	9
5. ....increase my sense of self-worth.	0	1	2	3	4	5	6	7	8	9
6. ....have a career that is valued by my family.	0	1	2	3	4	5	6	7	8	9
7. ......do work that can "make a difference" in people's lives.	0	1	2	3	4	5	6	7	8	9
8. ......go into a field with high employment demand	0	1	2	3	4	5	6	7	8	9
9. ......do exciting work	0	1	2	3	4	5	6	7	8	9
10. .....have the right type and amount of contact with other people (i.e. "right" for me).	0	1	2	3	4	5	6	7	8	9

Appendix F

Negative Engineering Outcome Expectations

The Negative Outcome Expectations Scale-Engineering (NOES-E)
Lee, Flores, et al. (2018)

Instructions: Using the scale 0 to 9 below, please indicate the extent to which you agree or disagree with each of the following. Graduating with a BS degree in Engineering will likely result in:

	Strongly Disagree			Disagree	Unsure	Agree			Strongly Agree
1. Not having a personal life	0	1	2	3	4	5	6	7	8	9
2. Feeling intimidated by the competitive work environment.	0	1	2	3	4	5	6	7	8	9
3. Difficulty working with mostly male colleagues	0	1	2	3	4	5	6	7	8	9
4. Facing complaints from my partner and family due to long working hours.	0	1	2	3	4	5	6	7	8	9
5. Doing boring work.	0	1	2	3	4	5	6	7	8	9
6. Limited access to mentors who understand me.	0	1	2	3	4	5	6	7	8	9
7. Needing extensive, additional training beyond a bachelor's degree	0	1	2	3	4	5	6	7	8	9
8. Unwelcome comments about my appearance	0	1	2	3	4	5	6	7	8	9
9. Feeling hurt due to criticism of my performance	0	1	2	3	4	5	6	7	8	9
10. Feeling like an outcast among family and friends.	0	1	2	3	4	5	6	7	8	9

Appendix G

Persistence Intention in Engineering

The Engineering Persistence Intention (EPI)
Lent et al. (2003)

Instructions: Using the scale below, indicate your level of agreement with each of the following statements. How much do you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1. I intend to major in an engineering field.	1	2	3	4	5
2. I plan to remain enrolled in an engineering major over the next semester.	1	2	3	4	5
3. I think that earning a bachelor's degree in engineering is a realistic goal for me	1	2	3	4	5
4. I am fully committed to getting my college degree in engineering.	1	2	3	4	5

Racial/Ethnic Stigma Consciousness

The Stigma Consciousness Questionnaire-Race (SCQ-R)
Brown & Lee (2005), Pinel (1999)

Instructions: Using the scale below, indicate the extent to which you agree or disagree with the following.

	Strongly Disagree			Neither Agree nor Disagree			Strongly Agree
1. Stereotype about my racial/ethnic group have not affected me personally.	1	2	3	4	5	6	7
2. I never worry that my behaviors will be viewed as stereotypical of my racial/ethnic group.	1	2	3	4	5	6	7
3. When interacting with others, I feel like they interpret my behaviors based on my racial/ethnic group.	1	2	3	4	5	6	7
4. Most people do not judge my racial/ethnic group on the basis of race/ethnicity.	1	2	3	4	5	6	7
5. My being racial/ethnic group does not influence how others act with me.	1	2	3	4	5	6	7
6. I almost never think about my racial/ethnic group when I interact with others.	1	2	3	4	5	6	7
7. My being racial/ethnic group does not influence how others act with me.	1	2	3	4	5	6	7
8. Most other people have a lot more racist thoughts than they actually express.	1	2	3	4	5	6	7
9. I often think that others are unfairly accused of being racist.	1	2	3	4	5	6	7
10. Most people have a problem viewing my racial/ethnic group as equals.	1	2	3	4	5	6	7

Appendix H-1

Coping Efficacy-Career

Selected items within Coping with Barriers (CWB)-Career
Luzzo & McWhirter (2001)

Instructions: Using the scale below, rate your degree of confidence that you could <u>overcome</u> each of the potential career barriers listed below.

	Not at all Confident				Highly Confident
1. **Discrimination due to my gender**	1	2	3	4	5
2. **Discrimination due to my ethnicity**	1	2	3	4	5
3. **Negative comments about my sex (insults, jokes)**	1	2	3	4	5
4. **Negative comments about my racial/ethnic background (insults, jokes)**	1	2	3	4	5

Appendix H-2

Coping Efficacy-Education

Selected items within Coping with Barriers (CWB)-Education
Luzzo & McWhirter (2001)

Instructions: Using the scale below, rate your degree of confidence that you could <u>overcome</u> each of the potential educational barriers listed below.

	Not at all Confident				Highly Confident
1. Not being smart enough	1	2	3	4	5
2. Not fitting in at college	1	2	3	4	5
3. Lack of support from teachers	1	2	3	4	5
4. Not being prepared enough	1	2	3	4	5
5. Not knowing how to study well	1	2	3	4	5
6. Not having enough confidence	1	2	3	4	5
7. Lack of support from friends	1	2	3	4	5
8. My gender	1	2	3	4	5
9. People's attitudes about my gender	1	2	3	4	5
10. My ethnic background	1	2	3	4	5
11. People's attitudes about my ethnic background	1	2	3	4	5
12. Lack of role models or mentors	1	2	3	4	5

VITA

Bo Hyun Lee was born in Seoul, South Korea, on June 22, 1985, as the daughter of Yong Bok Lee and Young Bin Lim. After completing the Bachelor of Arts and Bachelor of Science in Education and Mathematics Education, respectively, at Korea University, Seoul, in 2009, she worked as a mathematics teacher in Dong Buk High School for a year. She entered the Graduate School in the Department of Educational Psychology, Counseling, and Special Education at the Korea University in 2011 and received a Master's of Arts degree in Counseling in 2014. After working at the Korean Youth Counseling & Welfare Institute as a counselor, she entered Counseling Psychology program at the Educational, School, and Counseling Psychology department at the University of Missouri (MU) in 2015 and earned a Doctor of Philosophy in Counseling Psychology in 2021. She is currently completing a psychology internship at the University of Florida Counseling and Wellness Center.